THURSDAY, AUGUST 24, 1916.

COAL-TAR AND AMMONIA.

Coal-Tar and Ammonia. By Prof. G. Lunge. Fifth and enlarged edition. Part i. *Coal-Tar.* Pp. xxix + 527. Part ii. *Coal-Tar.* Pp. xi+531 to 1037. Part iii. *Ammonia.* Pp. xvi+1041 to 1658. (London: Gurney and Jackson, 1916.) Price, three parts, 3*l.* 3*s.* net.

THIS well-known book is one of the acknowledged classics of chemical technology. Originally published in 1882, it has now reached its fifth edition. Perhaps nothing could possibly serve to illustrate more strikingly the extraordinary development of chemical industry during the past third of a century than a comparison of the contents and size of the volumes of the successive editions. The 1882 edition, which all authorities agreed was a faithful reflection of the then condition of this particular industry, consisted of a modest volume of some 370 pages, of which about 300 treated of coal-tar, its origin, properties, distillation, fractionation, etc., while fewer than sixty pages were devoted to the subject of ammoniacal liquor, its treatment, and the manufacture of the more industrially important ammoniacal salts, the remainder of the book comprising tabular matter, conversion tables, appendix, and index.

The present (1916) edition extends to three volumes, each of which is nearly double the size of the single volume of which the first edition consisted. Two of these volumes are taken up with coal-tar and its products, while the third treats exclusively of ammonia and its commercial compounds. It may serve to indicate the importance which this subject has assumed to state that the space which has now to be given to it is nine times greater than was needed some thirty-four years ago.

In the first edition no attempt was made to estimate the amount of the by-products obtained in the destructive distillation of coal. In the early 'eighties the industry, although no longer in its infancy, was still comparatively undeveloped, and statistics were not readily available, nor when obtained were they very consistent. Wurtz, in 1876, in connection with the early history of the coal-tar colouring matters, had estimated the total production of coal-tar in Europe at about 175,000 tons, of which Great Britain produced about 130,000 tons. Weyl, of Mannheim, some years later, put the amount for all Europe at 350,000 tons, of which England produced more than half, exclusively, of course, from gas-works. In 1880 Germany worked up only 37,500 tons. In 1883 the total production of the principal European countries was stated by Gallois to be 675,000 tons, of which Great Britain produced 450,000 tons and Germany 85,000 tons. At about that time (1884), according to a report of the directors of the South Metropolitan Gas Company, the sale of tar and sulphate of ammonia realised 82 per cent. of the initial cost of the coal incidentally employed. "Residuals," however, do not always command such prices. Tar, for example, has fluctuated in value in recent years from 26*s.* a ton in 1903 to as low as 11*s.* in 1909. Owing to the special circumstances of the times it has doubtless greatly increased in price.

The production of tar and the working up and treatment of tar-products and "residuals" generally have made enormous strides in Germany during recent years, and she is now, in all probability, no longer dependent upon outside sources as she formerly was. Very recent statistics are, of course, not to be looked for. The latest which are available for a comparison between our position and that of Germany in this respect refer to 1909, and no doubt are not strictly applicable to the present abnormal conditions. But even as they stand they are very significant, and leave no room for doubt as to their meaning.

According to the figures furnished by the author the amount of tar produced in the United Kingdom in 1909 was 1,100,000 tons, made up as follows:—

	Tons
Gas-tar	750,000
Coke-oven tar	150,000
Blast-furnace tar	200,000
	1,100,000

In the same year the aggregate production of tar from all sources in Germany was 1,012,000 tons. In other words, whilst the United Kingdom had rather more than doubled her production in about twenty-five years, Germany, during the same interval of time, had increased her supply by about twelve times the amount. There can be little doubt that her production at the present time exceeds that of the United Kingdom and that we have now definitely lost our pre-eminence in this particular industry. The greatly increased production in Germany would appear to be due to the extraordinary development of the coke-oven industry which has taken place within recent years in that country. There is at the present time about three times as much coke-oven tar produced in Germany as of gas-tar, whereas with us the amount of coke-oven tar until quite recently was barely half that of the gas-tar. This great disparity in the rate of development of this particular phase of the industry is, no doubt, due to several causes, some of them, possibly, purely economic. On the other hand, something must be set down to the conservatism and apathy of coalowners and to the prejudice of ironmasters. It is lamentable to think how one of the greatest assets this country possesses continues to be wasted through ignorance and neglect. Some day we shall wake up to the fact that we have heedlessly squandered the potential riches with which we have been endowed.

Considering the part played by coal-tar

products in furnishing certain of the raw materials needed in the manufacture of high explosives, the astonishing development of the coal-tar industry in Germany affords one more illustration of the means by which that country has so sedulously prepared herself for the titanic struggle upon which she has embarked.

It remains to be seen what the influence of the war will be on the future of tar production and distilling in this country. It is practically certain that Germany will no longer be the market for our intermediate tar-products that she has hitherto been. Dr. Lunge tells us, what we begin to realise, that Germany "is now in a position to furnish almost the whole of the requirements of coal-tar products for its colour industry, the largest in the world." What is in store for the colour industry with us is very difficult to forecast. Time and a more intelligent fiscal policy may tell. As we all know, attempts are being made to recover the great leeway we have lost by our lack of foresight and our want of an intelligent appreciation of the relation of science and research to industry. It is to be hoped, in the interest of our textile manufactures, that at least a certain measure of success may be reached. But it is questionable whether, on the lines of the present effort, the success will be very far-reaching. It is certain that the methods which are being employed are very different in character from those which have placed the industry in its present high position in Germany. It is no less certain that no other mode of direction than this last will be successful in the long run.

As compared with the preceding edition, which appeared in 1909, the most important factor of increase in the present work is in the section relating to ammonia, concerning which there has been a great development within recent years. Ammonia and ammoniacal compounds are, of course, used to a large and increasing extent in a great variety of industries, *e.g.* manufacture of alkali; coal-tar colours; in bleaching, dyeing, and calico-printing; in zinc-coating; explosives; artificial silk; medicine, pharmacy, and photography; and in the production of cold. But by far the largest amount of combined ammonia is used in agriculture. During the first decade of this century the consumption of ammonium sulphate rose from 125,000 to 322,000 tons, whereas during the same period the consumption of sodium nitrate rose from 470,000 to 637,000 tons—a far less rapid rate of increase than in the case of the ammoniacal salts, which is bound to get still less as the Chile beds approach exhaustion. Although synthetic methods of production of ammonia will play an increasingly important part, it is practically certain that the principal source of ammonia and its compounds will continue to be the nitrogen of coal, and it is on the development of the coking industry and on the recovery of the by-products formerly lost that the future of the ammonia industry will depend.

We heartily congratulate the veteran Professor Emeritus of the Zurich Federal Technical University on the appearance of this admirable work. Dr. Lunge deserves well of the industry which he has laboured so faithfully to serve. Every page of his treatise bears witness to the zeal and painstaking care with which it has been compiled and revised. The book, as hitherto, is admirably printed and excellently illustrated. Indeed, no efforts have been spared by all concerned to make it, what it unquestionably is, by far the most complete and authoritative work we have upon the important subjects of which it treats.

T. E. THORPE.

MATERIALS OF CONSTRUCTION.

The Structure and Properties of the More Common Materials of Construction. By G. B. Upton. Pp. v+327. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916.) Price 10*s.* 6*d.* net.

THIS volume had its origin in a course of theoretical instruction preparatory to a laboratory course at Sibley College, Cornell University. The first part deals with the elastic theory and the determination of the properties of materials of construction, chiefly metals, by testing. The ordinary rules connecting stress and strain are discussed, but not in general the instruments used in testing. Rather more attention is given to the behaviour of materials strained beyond the elastic limit than in treatises on applied mechanics. Some of the statements are rather too dogmatic. Is the author sure that in a tension test "the break must start at the outside and work inwards" (p. 36)? English engineers will scarcely agree with the statement that "there is not much excuse for the use of the Rankine or Ritter formulas" for columns. It will be new to them to learn that "live loads applied without shock (for example, a rolling load crossing a bridge at low speed) actually set up stresses twice as great as a dead load of the same amount." The injurious effect of a live load without shock as compared with a dead load is, not that it increases the stresses, but that it causes the "fatigue" effect. Of course, also, it produces shocks, which the author deals with separately. A live load is not a suddenly applied load. Nevertheless, this section is generally clear and useful. The discussion of the cause of fatigue failure is fuller than usual. No attempt is made to give collections of results of tests.

The second and rather larger part of the book deals with the internal structure of materials and its modification by mechanical action, heat treatment, etc. Is it true that the corrosion of iron "takes place whenever the moisture in contact with the metal becomes electrolytic either by acids or *alkalies*"? Freezing-point and equilibrium diagrams for lead-tin and iron-carbon alloys are described, and the constituents of cast-iron and steel, austenite, pearlite, ferrite, cementite, etc., are discussed very fully. So also are the variation of the properties of steel with the carbon content and the influence of nickel, manganese, vanadium, chromium, etc. The author gives a general theory of the heat treatment of steels which is original, and which, the author believes, throws much light on practical problems and is certainly interesting. Cements are shortly treated in a final chapter.

Although some defects, probably due to haste, have been indicated, this treatise is really a good one and can be recommended to practical engineers as containing information not easily accessible elsewhere. Perhaps the fault of being rather too positive in accepting conclusions not fully established is one to which a teacher of students is specially liable.

SOUND ANALYSIS.

The Science of Musical Sounds. By Prof. D. C. Miller. Pp. viii + 286. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1916.) Price 10*s*. 6*d*. net.

UNDER the above title the author has presented in book form a series of eight lectures on sound analysis delivered at the Lowell Institute in January and February, 1914. A course of scientific lectures designed for the general public must consist in large part of elementary and well-known material, selected and arranged to develop the principal line of thought. But it is expected that lectures under the auspices of the Lowell Institute, however elementary their foundation, will present the most recent progress of the science in question. It is further expected that such lectures will be accompanied by experiments and illustrations to the greatest possible degree.

Thus, in the present work, we find that mathematical treatment is almost absent; the few equations that occur throughout its pages might be collected so as to appear at a single opening of the book. On the other hand, the figures number nearly two hundred, many of them being photographic reproductions of vibration curves or apparatus. These serve to indicate the wealth of the demonstrative material by which the lectures were illustrated.

The first lecture deals with sound-waves, simple harmonic motion, noise, and tone; the second with the characteristics of tones. The third lecture is concerned with methods of recording and photographing sound-waves, and includes a description of the author's special recorder called the *phonodeik*. Lectures four and five develop the analysis and synthesis of compound harmonic curves, and treat the influence of horn and diaphragm. The sixth and seventh lectures are concerned with the tone qualities of musical instruments and the physical characteristics of the vowels. The eighth lecture treats the problems of the synthesis of vowels and words, and concludes with remarks on the relations of the art and science of music.

The work includes a valuable bibliographic appendix of more than a hundred references. The type and illustrations are large and clear, and the book should prove welcome to a wide circle of readers and find an honoured place in every acoustical library.

E. H. B.

OUR BOOKSHELF.

Studies in Blood-Pressure, Physiological and Clinical. By Dr. George Oliver. Edited by Dr. W. D. Halliburton. Pp. xxiii + 240. Third edition. (London: H. K. Lewis and Co., Ltd., 1916.) Price 7*s*. 6*d*. net.

THIS posthumous edition opens with an obituary notice of the author by Prof. Halliburton, who has undertaken the duties of editor as a "true labour of affection and respect." This latest edition embodies the chief advances in the clinical investigation of blood-pressure, and contains a description of the author's own instruments for testing the pressure. It is argued that the condition of the vessel wall does not seriously interfere with correct readings; hypertonicity, which produces the greatest resistance, can be counteracted by repeated compression or massage. It is noteworthy that occupations involving anxiety, worry, and nerve strain tend to augment blood-pressure. It is pointed out that "pulse-pressure" (the difference between the systolic and the diastolic pressure) tends to increase after the age of forty. The suggestion that arterio-sclerosis may be so advanced as to cause an entire abolition of vasomotor control is open to question; for it is difficult to see how life could be carried on under such conditions. The author holds that widespread thickening of the arterial wall suffices to maintain long-continued high pressure, and that there is no need to postulate persistent hypertonicity of the arteries, which he considers physiologically improbable.

The Chemistry of the Garden: A Primer for Amateurs and Young Gardeners. By Herbert H. Cousins. Revised edition. Pp. xviii + 143. (London: Macmillan and Co., Ltd., 1916.) Price 1*s*.

WHEN the demand for a book is such that it needs to be reprinted eight times since its first issue in 1898 and now calls for a revised edition, it obviously needs little commendation to the public for whom it is written. Mr. Cousins's volume contains in its 143 pages a vast amount of information on the management of soil for the successful production of garden crops. In the new edition we notice reference to recent Rothamsted work on partial sterilisation and to the shortage of potash caused by the war. On the latter account the gardener need not worry, as any moderately good garden soil has ample reserves of potash, which can be made available as plant food by suitable treatment. We do not agree with two of the author's remarks on dung. He says that "no analysis is of much value": on the contrary, experience at Rothamsted and elsewhere shows that the crop yields consistently follow the chief analytical figures, and especially the ammonia. Again, stable (horse) manure is said to be more liable to loss on keeping than cow manure. Recent experiments show that horse manure loses much less nitrogen than cow manure during storage for periods of three or four months. The chapter on garden remedies and insecticides is likely to be very useful this summer, when pests of all kinds are unusually active. E. H. R.

The World and its Discovery. By H. B. Wetherill. Part i., *Africa*, pp. 119. Part ii., *Asia*, pp. 99. Part iii., *America*, pp. 131. Part iv., *Australia*, pp. 62. (Oxford: At the Clarendon Press.) Price 1*s*. each.

MR. WETHERILL has a story of surpassing interest to tell, and he succeeds in conveying, by means of the accounts of the work of the chief explorers, a succinct summary of the main features of the geography of the four continents other than Europe. Told in this fashion, with the emphasis on the lands and their peoples, the geography of the remoter continents becomes vivid, and thus appeals to the pupils with a sense of reality; experience with this book leads to these conclusions. For example, the characteristics of the people and the lands near the Gambia and the Niger gain in precision and definiteness in relation to the travels of Mungo Park; and the gradual development of the story of the conquest of the Central Australian desert provides a useful account of the control exerted upon life on the earth by the absence of rain in a hot region.

LETTERS TO THE EDITOR.

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

The Formation of Dust-ripples.

LAST evening when returning from a visit to the trenches I noticed an interesting illustration of the formation of dust-ripples. A battery of field-guns had been placed nearly parallel to a road some 2000 yards behind the lines. Owing to the continued fine weather the roadway was covered by a coating of fine dust. The guns were about 100 yards from the road, on lower ground, and pointing so that the shells just cleared. The battery had been in action all day. There was very little wind and no traffic over the road during day-time. The whole surface of the road in front of the guns was covered by a series of small ripples at right angles to the direction of the guns. The ripples were about 1/12 in. apart, from east to west. They were evidently caused by the explosive wave passing over the road. The same effect can be produced by discharging a Leyden jar across a spark-gap near a card on which some light powder has been sprinkled, or by tapping sharply a piece of parchment stretched tightly over the end of a lamp-glass containing fine powder. H. U. G. (C.F.).

France, August 10.

A Sunset Phenomenon on July 22.

REFERRING to the sunset phenomenon seen on July 22, and described in NATURE of July 27, it seems probable from information kindly sent by various correspondents that the clouds seen were somewhere in the neighbourhood of Plinlimmon. If this were the case, the height of the tops of the clouds would have been from 18,000 to 18,500 ft., and the two clouds would have been about eight miles apart. A correspondent who watched the sunset from Minchinhampton Common reports that no clouds were visible from there, but even from so far west the altitude of clouds at a height of 18,000 ft. over Plinlimmon would not have exceeded 1° 40′, and they would have only been visible if the horizon were a good one and the atmosphere very clear. In asking for information from Ireland I was casting my line too far; the top of a cloud the height of which is 24,000 ft. (which is probably high for a cumulo-nimbus in these latitudes) would not be visible more than 190 miles away. The distance of Plinlimmon from Farnborough is 154 miles; clouds at such distances can probably only be seen when the sun sets behind them in an otherwise clear sky. C. J. P. CAVE.

Meteorological Office, South Farnborough, August 14.

The Utilisation of Waste Heat for Agriculture.

WITH regard to Mr. Carus-Wilson's fear (NATURE, July 27) that the heating of the earth will multiply pests, one may point out that earth-warming is already greatly used. Large areas of land are covered by glass to maintain a high temperature, and land is also heated directly for forcing rhubarb. One may conclude that farmers would welcome further means for heating the land if the expense were not too great.

If the waste heat from electricity stations were used in the manner I have suggested, it would still be possible to remove the heat during winter months to destroy pests, if this were found desirable, or we could even cool the ground artificially.

I would like to mention here Prince Kropotkin's astonishing book, "Fields, Factories, and Workshops," in which he shows that agriculture may be speeded up in a way that would surprise most people who look on farming as an almost non-progressive industry. In it the author states that even in France, with its abundant sunshine, growers are experimenting with the direct heating of the soil, and if found an advantage there, surely it would be even more so in this country. C. TURNBULL.

Electricity Works, Tynemouth, August 4.

A Peculiar Thunderclap.

THE writer would suggest as an alternative explanation of the peculiar thunderclap described by Mr. Don (NATURE, August 17) at different places within the circumscribed area he mentions that probably the lightning discharges were not from cloud to earth, but in the reverse direction, from a large area of ground heavily charged relieving itself at several points simultaneously. H. O. F.

ENGINEERING EDUCATION AND RESEARCH IN RELATION TO THE ORGANISATION OF BRITISH ENGINEERING INDUSTRY.

THE Manchester Engineers' Club, which was established about three years ago, includes among its members most of the leading engineers in South-East Lancashire. During the first winter of the war a series of debates was held in the club on problems connected with the future of British engineering. About Easter, 1915, a committee was appointed to bring together some of the suggestions which had most commended themselves to the club in the course of these debates. The committee met weekly during the summer of 1915, and in November last presented its report to the club. This report was unanimously adopted.

A number of members of the club then formed themselves into a "Council for Organising British Engineering Industry," and proceeded at once to secure the support of engineering firms in the neighbourhood of Manchester. At the present time, almost every important engineering concern in the Manchester district, and all but very few throughout South-East Lancashire, have promised their support to the movement. Moreover, the professional societies which have been approached by the Council have replied sympathetically, and have, for the most part, promised their active co-operation.

The time has come for the extension of the movement so as to make it of national dimensions. Steps have already been taken to extend its activities to the Midlands, where influential support is assured. Meanwhile, the British Engineers' Association has been moving in a similar direction. The fusion of the two movements appears to be imminent. When that fusion has taken place, the process of organising British engineering industry should proceed more rapidly still.

The report which led to the establishment of the Council for Organising British Engineering Industry began by pointing out that the development of British engineering export trade had been highly unsatisfactory for some years, while Germany had been making rapid progress. The report suggested that Germany's success had been due "to education, to co-operation, and to organisation in manufacturing and selling, backed up by adequate financial support; in Britain, on the other hand, education" had been "unsystematic, organisation weak, and co-operation between competing firms almost non-existent." The committee concluded that every British engineer ought now to realise that his British competitor in some markets must be his friend and ally in others; and that, in short, the time had come for the federation of British manufacturing engineers so as to organise the industry. The report proceeded to describe in outline the association of manufacturing engineers which the committee would like to see formed. The co-ordination and development of education and research were given prominent places among the functions of the proposed association.

Since the adoption of the report and the establishment of the Council, the question of engineering education and research has continued to receive attention. In evidence given on behalf of the Council to the Board of Trade Committee on the Iron, Steel, and Engineering Trades, special emphasis was laid upon the Council's view that, without the co-operation of engineering manufacturers in the education of engineers and without a great increase in the volume of engineering research, no amount of organisation could place the British engineering industry on a permanently satisfactory basis. The Board of Trade asked for further particulars of the Council's proposals in regard to education and research. The Council accordingly appointed a committee to report further upon this matter. The following is a summary of the committee's recommendations, which have been approved by the Council and forwarded to the Board of Trade:—

1. The organisation of British engineering industry, by the federation of British manufacturing engineers, for purposes which include education and research. Such a federation should co-operate with governing bodies of schools and colleges, as well as with education authorities, in providing a satisfactory system for educating engineers; with universities and colleges in testing and research; and with the Government in conducting a central research institution specially equipped for investigations with which existing research laboratories are unable to cope.

2. The co-ordination of the existing means for educating engineers and, in particular, the provision of an adequate and more uniform system of scholarships. To this end, the number of local education authorities for the highest education should be much reduced, correspondingly larger areas being assigned to each.

[This recommendation was supported by an appendix showing the number and value of the university scholarships at present offered by various local education authorities. It appeared from these figures that a candidate's chance of winning such a scholarship largely depends upon the particular town in which he happens to live.]

3. That a large number of "junior technical schools" be established for the education between twelve and fifteen of boys who intend to become apprenticed to engineering trades.

4. That all apprentices under eighteen years of age be required to attend part-time classes for, say, eight hours a week during works hours; but that this be subject to certain exceptions in the case of young people who continued in attendance at secondary or junior technical schools up to at least fifteen years of age.

5. That the instruction given to trade apprentices in these part-time classes be reformed so as to relate it more closely to the apprentices' everyday work and so as to include what are known as citizenship subjects—for example, economic history; and that, where a sufficient number of apprentices is employed by the same firm, such classes be conducted in that firm's own works and by the works staff.

6. That the specific education given to future members of the highly trained staff be provided in a university or college of university rank for the majority, who should be enabled to continue their studies up to twenty-one or twenty-two years of age; and in a "senior technical school" for the minority, who may have to enter engineering works at eighteen.

7. That boys who are to study engineering in a university should carry their study of mathematics and physical science to a higher stage before leaving school, and that, in general, the education of a boy at school, instead of being entrusted (as in some modern secondary schools) to six or seven specialist teachers whose business it is to advance his know-

ledge of an equal number of separate subjects to a uniform level of mediocrity, should be in the hands of a succession of form masters, who, knowing their boys well, may exercise a profound influence upon their characters and carry to a high level their studies in a more coherent curriculum.

8. That the conditions for admission to universities should be reconsidered and rendered more uniform as between different universities and less uniform as between different faculties and different honours schools in the same university; and that, in the interest of candidates of mature age and of other candidates approaching the university otherwise than through the normal avenue of the secondary school, university entrance tests should be distinguished from secondary school examinations.

9. The reform of university teaching in certain important respects, notably by a reduction in the number of lectures.

10. That the completion of a three years' university course in engineering should entitle students to no more than the B.A. degree; and that, until candidates have added works experience to academic training, they should not receive technical degrees (such as Bachelor of Engineering or Bachelor of Technical Science) which might then serve as professional qualifications.

11. That any time spent in works between school and college should not be unduly prolonged.

12. That university teachers be encouraged to undertake research on behalf of, and in co-operation with, manufacturing firms; and that additional Government grants be paid to universities and colleges with this end in view.

13. That, by the establishment of such an association of manufacturing engineers as we have advocated and by other means, the volume of research work carried out in connection with the British engineering industry be greatly increased; and that provision be made for this increase in the volume of research by fully utilising and extending the facilities already available in universities and colleges, as well as in the works of private firms, and also by establishing a central research laboratory for investigations that cannot be undertaken elsewhere.

The report was accompanied by a diagram illustrating the scholarship system recommended by the committee. This diagram differs but slightly from one reproduced in NATURE of October 21, 1915 (vol. xcvi., p. 214).

J. C. M. G.

THE OPTICAL INDUSTRY IN FRANCE.

A SERIES of articles by various authors has recently been appearing in the *Revue générale des Sciences* on the methods to be adopted for the development of French trade after the war. Amongst these have appeared two articles (May 30 and June 13) by M. A. Boutaric on the French optical industry and its future.

He points out that before the Napoleonic wars France had been dependent on England for its optical glass, and it was as a result of the British blockade that its manufacture was commenced in France.

At the present time the house of Parra-Mantois manufactures practically all the special optical glasses made by Schott and Co., and the French makers undoubtedly are more successful than their competitors in the manufacture of the glass discs required for very large astronomical mirrors and objectives. In every branch of optical science French physicists have invented instruments and methods for testing their qualities, but the French manufacturers have not done themselves justice by an efficient catalogue propaganda. M. Boutaric, when referring to the firm of Zeiss, mentions especially that it "has surrounded its products with a scientific propaganda." He shows how severe the German competition in microscopes was before the war, although there are two good French makers—Nachet and Stiassnie. The metallurgical microscope of Le Chatelier has been developed by Pellin with considerable success. The polarimeter in its present commercial form was developed by the French makers Soliel and Laurent, and is essentially a French instrument, yet the German houses have almost obtained a monopoly in the sale of the instrument outside France.

The manufacture of binoculars is the most successful of all the French optical industries, several large firms (Balbreck, Baille-Lemaire, Société française d'Optique, Société des Lunetiers, etc.) being employed in their manufacture. As showing the large quantity of optical glass used in these glasses, it is stated that the Société des Lunetiers alone use about 200,000 kilos of glass annually.

Although French makers showed several prism binoculars of the Porro type at the 1867 Exhibition, yet the manufacture of these glasses passed almost entirely to Germany. Now, however, glasses equal to the best German models are being made in France in large numbers for her Army and those of her Allies. The original supremacy of the French photographic lens has passed away, because, in the opinion of M. Boutaric, the French makers did not use the new glasses and modern grinding methods, nor sufficiently avail themselves of skilled technical knowledge. M. J. Richard has developed with great skill and success a stereoscopic camera, the "Verascope," and also a very rapid camera shutter, but the majority of the cameras used in France have been imported. The kinematograph, the invention of a Frenchman, Prof. Marey, has been carried to a high state of perfection by the firms of Lemaire, Pathé, and Gaumont. To a certain extent France is dependent on outside sources for kinematograph film, but, on the other hand, she exports finished printed film to the annual value of 600,000*l*. The lighthouse industry, built on the theoretical work of Fresnel, is a successful one, although it has had to face keen competition from English and German makers.

M. Boutaric points out that although in nearly all optical matters French savants are the pioneers, yet the French optical industry is very small as compared with the German. In an interesting paragraph he endeavours to analyse the reasons for this success. "Here, as in everything else, the Germans have been saved by their deep sense of business. The German industry demonstrates by a wise publicity the worth of its goods, sometimes excellent, but sometimes also copies of our models and inferior to ours; their catalogues, well edited and illustrated, are published in many languages, and give full details of the instruments they describe, their travellers, men of parts, knowing intimately their instruments . . . and trying to satisfy the wishes of their customers."

M. Boutaric points out that the collaboration between the man of science and the manufacturer is far more close in Germany than in France. In the former the man of science is in intimate touch with the works, and is well paid for his services. The foreman and apprentices are trained in the theoretical side of their subject in classes they are obliged to attend. In the firm of Zeiss half the time spent by the workers in the technical classes is counted as time spent in the works. No steps are neglected to perfect the organisation as a whole; everything is done to make the machine independent of a single individual. In France the success and reputation of a firm have too frequently depended on one individual. That some steps are being taken to strengthen the optical industry in France is shown by the fact that a large factory has been built by La Société française d'Optique, formed in conjunction with the firm of Lacour-Berthiot, for meeting the competition of the best German firms. M. Boutaric urges that if the future of the industry is to be assured, new blood must be introduced, young mechanics trained, and a school of optics founded. This school, for which M. Violle has pleaded, should be divided into at least two sections: optics proper and photography. In it practical classes on glass grinding, etc., should be given in conjunction with theoretical work.

After an appeal for mutual co-operation between the various firms and individuals interested, M. Boutaric urges that the Government should take steps to protect French patents and trade marks against unfair competition. Anyone with experience of the laxity of the French patent specification and patent laws will appreciate the force of this appeal.

ARCTIC OCEANOGRAPHY.

IMPORTANT contributions to Arctic oceanography are contained in the report of Dr. F. Nansen's work in Spitsbergen seas in 1912 ("Spitsbergen Waters." By F. Nansen. Christiania, 1915). Dr. Nansen spent July and August of that year in his yacht, the *Veslemöy*, on the west and north of Spitsbergen. His main object was to push far to the north to get deep-water samples from the polar basin in order to make more accurate determinations of specific gravity than were possible during the voyage of the *Fram*. But this aspect of the expedition was only partially successful on account of the pack ice being unusually far south. However, a great deal of valuable work was done, both in the open seas and in the fjords. Only one or two of many interesting results can be noticed here.

It has been maintained that the melting of glacier ice has a considerable cooling effect on the water strata of Spitsbergen fjords. Dr. Nansen confutes this idea. He took a vertical series of temperatures at the entrance to Ice Fjord in July, when it was clear of ice, and again in August, when ice almost blocked the way. The water at 50 metres and the intermediate cold layer were much warmer in August than in July. Again, in Cross Bay, at both 100 and 200 metres from the face of Lillehook Glacier, the cold intermediate layer was both thinner and warmer than further out in the fjord. The bottom temperatures near the glacier were also higher than further out in the fjord. But as the surface salinity was greater near the glacier than further away it would appear that the glacier ice does not melt rapidly at the upper end of the fjord. The high salinities of the inner end of the fjord may be in part due to the more extensive formation of ice in winter there than further out, which would increase the salinity.

Another important matter raised in this paper is the extension and shape of the north polar basin. In this matter Dr. Nansen has modified his views since the days of his *Fram* expedition. The result of that expedition led to the belief that the water of the north polar basin differed from that of the Norwegian Sea. The work of the *Veslemöy* contradicts this, and shows that the salinities of the two are identical. The deep water of the north polar basin is probably derived from the Norwegian Sea. This discovery does away with the necessity for postulating a high submarine ridge between Greenland and Spitsbergen, yet one at a depth of about 1200–1500 metres is still necessary to account for the difference in temperature of the deep water in the two basins. In any case, if the deep water of the polar basin is derived from the Norwegian Sea and not formed in the basin itself, there is no need to believe in such an extensive polar basin as formerly was considered necessary. The discovery, a few years ago, by Vilkitski, of islands north of Cape Chelyuskin does something to confirm this belief in a less extensive deep basin. It is true that the Stefansson expedition found no new land, and that Peary's Crocker Land has apparently no existence, but these facts do not disprove the possibility of a wide continental shelf, and Nansen goes at considerable length into questions of the drift of the *Fram* and of the ice to substantiate the probability of this being the case. We have followed Nansen in using the form Norwegian Sea, but there seems to be no reason why this should replace the older and generally accepted name, Greenland Sea.

NOTES.

DR. J. O. BACKLUND, M. B. Baillaud, Sir F. W. Dyson, Dr. P. Lowell, Prof. F. Schlesinger, and Prof. H. H. Turner have been elected honorary fellows of the Royal Astronomical Society of Canada.

THE provisions of the "Summer Time" Act will cease to operate at the end of September. In a written answer to an inquiry raised by a member of Parliament the Home Secretary said:—"The three hours following midnight (Summer Time) of the night of September 30–October 1 are included in the Summer Time period. The change does not take place until 3 a.m. Summer Time, or 2 a.m. Greenwich Time, on October 1. At that hour the clocks will be put back one hour, so that the period 2–3 a.m. Summer Time will be followed by a period 2–3 a.m. Greenwich Time, and they can readily be distinguished by the addition of the words 'Summer Time' or 'Greenwich Time,' as the case may be."

WE announce with much regret the death, on August 20, at the age of fifty years, of Dr. T. Gregor Brodie, professor of physiology in the University of Toronto.

THE *Times* for August 11 contains a notice of the death in action of a very promising young geologist, Eric Warr Simmons, who was gazetted 2nd Lieut. in the 6th York and Lanc. Regiment in January, 1915. He took part in the landing at Suvla Bay, and was reported missing on August 11, 1915. He studied geology at University College, London, gaining several prizes and a university scholarship, and graduated with first class honours in 1914. He was a student-demonstrator in the geological department of University College. He was an enthusiastic member of the University O.T.C., and immediately after taking his degree applied for, and obtained, a commission. He had no time, therefore, for completing any original research. He was elected a fellow of the Geological Society in 1915. His death adds another name to the list of the younger generation of scientific men from whom much was expected who have perished in the war.

THE death is announced, in his sixty-fourth year, of Mr. C. W. H. Kirchhoff, one of the leading American authorities on metallurgy and allied subjects. A native of San Francisco, he graduated at the Royal School of Mines, Clausthal, Germany, in 1874, as mining engineer and metallurgist. Returning to America, he served for three years as chemist of a lead refinery in Philadelphia, and then joined the staff of the *Metallurgical Review*. His principal work in technical journalism was done in connection with the *Iron Age*, of which he was associate editor from 1884 to 1889 and editor-in-chief from 1889 to 1910. From 1883 to 1906 he was a special agent of the U.S. Geological Survey for the collection of statistics on the production of lead, copper, and zinc. He was elected president of the American Institute of Mining Engineers in 1898 and again in 1912. In 1910 he published "Notes on Some European Iron Districts."

THE sixty-first annual exhibition of the Royal Photographic Society opened last Monday at the Suffolk Street Galleries, and it is surprising to see how little effect the war has had upon the number and the interest of the exhibits. The chief, if not the only reminder of the crisis is a series of three official war photographs, panoramas made by the Printing Company of the Royal Engineers. They are enlargements of two diameters from 5×4 negatives, taken with telephotographic lenses (30 in. and 72 in. equivalent focal lengths) on panchromatic plates and with dense colour screens. They show the trenches. Each consists of several prints joined to form a continuous picture, and the quality of the work leaves, practically speaking, nothing to be desired. Among the photomicrographs is a fine series of sixty by Mr. G. Ardaseer of the Radulæ of Mollusca from specimens lent by the Rev. Prof. H. M. Gwatkin, Mr. E. A. Pinchin sends a series of Naviculæ, photographs of diatoms of a quality that has never been surpassed and rarely equalled, and Dr. G. H. Rodman's macroscopic and microscopic examples of the flora and fauna remains found in Coal Measures, from specimens in the Natural History Museum, form an extensive and very valuable series. Among the astronomical photographs, the most remarkable are by Dr. R. W. Wood of Saturn and Jupiter taken at Mount Wilson by the 60-in. reflector. Each planet is photographed by means of infra-red, yellow, violet, and ultra-violet light, and the differences are demonstrated by various combinations of these in different colours. Of the many other exhibits we have only space to refer to Mr. J. H. Gardiner's auto-radiographs of radium-bearing minerals, which clearly show the radium-bearing parts of each specimen, and Miss M. O. Edis's photographs of Sir James Dewar's 17-in. soap bubble taken during the first, second, and third weeks of its life, the last quite black and very near to the limit of thinness.

AN increased prevalence of acute poliomyelitis (infectious or infantile paralysis) is reported in New York and in Aberdeen. The somewhat alarmist notices on the subject in the daily Press are scarcely warranted at present, as the actual number of cases notified does not appear to be large in either case—forty-eight in the former and thirty-nine in the latter. But the disease is most prevalent in July, August, and September, so that the occurrence of further cases is likely. As regards the British Isles, the population in general, and adults in particular, seem to be relatively insusceptible. The early recognition and isolation of the first cases are important, for all the available evidence points to the transmission of the disease by direct contact with acute cases or carriers, and not by flies or vermin. The secretion from the nose or mouth nearly always seems to be the source of infection. The virus is easily destroyed by dilute solutions of disinfectants, and does not appear to be capable of survival for more than a very short period outside the human body.

THE American Museum has recently selected from its large collections a special exhibit of moccasins illustrating the principal patterns and their decoration, as well as the relation between the style of decoration and the structure. The true moccasin is almost confined to Canada and the northern two-thirds of the United States. So far as the data from the museum collections, described by Mr. C. Wissler in the *American Museum Journal* for May, indicate, it does not occur in Mexico or South America, but it extends to Siberia and Lapland. Though the types used by American Indians seem to be infinitely varied, they possess a few common structural features. As regards material, reindeer skin is used in the Old World and caribou in the New, two closely allied species. It thus turns out that the skin shoe is the correlate of the reindeer culture, a fact of interest to the ethnographer. As regards decoration, the styles were at the outset correlates of the structural pattern, serving at first some useful purpose; but when once they were established as styles they were carried over to footwear of other kinds where they serve no practical purpose.

THE designer of art fabrics, who is always in search of new sources of inspiration, may well direct his attention to the article on the decorative value of Indian art, by Miss E. A. Coster, in the May issue of the *American Museum Journal*. The patterns in Indian weaving have not the variety shown in Persian and Italian textiles, but possess strength, simplicity, and fine proportion. For the worker in ceramics there are unbounded possibilities, both in shapes and decorations. In metal-working the rosette type of decoration will be especially helpful. The author rightly observes:—"In adapting Indian motives the primitive spirit must be retained or the result will be a disappointment; but a reversion to the simplicity and free expression of Indian art is what modern craftsmen most need to counteract the tendency to over-decoration, mechanical technique, and lack of individuality."

THE question of the origin of the dolmen is a subject of active controversy into which we have at present no desire to enter. But for the benefit of those who are interested in the problem we may note the latest theory presented by Mr. Harold Peake in the August issue of *Man*. He suggests that prior to 2200 B.C. some traders from the north of the Ægean, familiar with the use of copper, and probably possessing the secret of bronze-making, set out from their home, which may have been Lemnos, in search of copper and tin. He notes in this connection the cult of the Dactyls or Cabiri, mysterious divine or heroic beings, at some centre in the south-east Ægean, and of Hephaistos at Lemnos, both connected with metal-working. These traders were also in touch with the Morbihan, possibly through the mediation of western merchants engaged in commerce on the Atlantic seaboard. At home they may have had relations with Crete, the Cyclades, and Hissarlik, and through the last with Cyprus. They were accustomed to erect Cyclopean walls, and learnt the use of cists from the people of the Cyclades. This combined knowledge they carried with them to the western people with whom they traded. The result was the evolution of the dolmen as we find it in the western Mediterranean and along the Atlantic seaboard.

THE *Zoologist* for July contains a most interesting account of the prevalent beliefs concerning animals, their uses, and the *rôle* they play in the mythology of South India, by Prof. Rae Sherriffs. At first sight this contribution might seem to represent no more than a collection of curious beliefs, founded for the most part on very slender knowledge. More closely examined, it will be found to afford a valuable insight into the habit of mind of the less educated portion of the population, which should be thoroughly understood by all Europeans who are engaged in administrative work in India. Having regard to the fact that there is still a great mortality from snake-bite in India, it is strange that the people as a rule have not acquired a more exact knowledge of these scourges. But the belief is still common that the cobra, the best-known snake of India and widely worshipped, is the female, and the rat-snake the male, of a common species. We look forward to the promised continuation of this theme.

UNDER the title of "The Free-living Nematodes of the Gulf of Sevastopol" an important monograph by I. Filipjev has recently been published in the Proceedings of the Sevastopol Biological Station and of the Zoological Laboratory of the Imp. Acad. Sci., Petrograd. This work is of special interest in that it gives for the first time a description of the Nematode fauna of the Black Sea, a group of Vermidea which presents great difficulties from a systematic point of view, and has therefore been less investigated than other groups of Vermidea. Filipjev's work is in three parts:—(1) Systematic, including the description of about a hundred species of Nematodes, of which some eighty are new, and a few new genera. (2) Morphological, containing many new anatomical data. (3) General, giving the topographical distribution and synoptical tables of genera and species.

REPORT No. 108 of the U.S. Department of Agriculture consists of an admirable summary by Nathan Banks of the Acarina or mites "for the use of economic entomologists." This booklet of 153 pages contains a general introduction to the structure and life-history of mites and a synopsis of the families and principal genera of the order, illustrated by nearly 300 figures, and concluding with a bibliography and index. Though primarily intended for use in America, Mr. Banks's work cannot fail to be of service to British students who, not having special knowledge of the Acarina, are called on to classify members of this difficult order. Under the heading "Uncertain Acari" reference is made to the Linguatulida and the Tardigrada; it is somewhat surprising to find the Pycnogonida—which are surely further from mites than any other order referable to the Arachnida—in the same assemblage.

THE current number of the *Quarterly Journal of Experimental Physiology* contains a long and valuable paper by Dr. E. G. Boring on the return of sensation after the division of cutaneous nerves. The author lays great stress on the importance of statistical methods and of the standardisation of the experimental conditions in investigations of this nature. He further points out that the analysis of the nature of the cutaneous sensations, as they return during regeneration of a divided nerve, calls for psychological as well as physiological training. As a result of his own observations, the author has failed to confirm some of Head's observations, and he entirely disagrees with the hypothesis of the existence of "protopathic" and "epicritic" sensibility which was advanced by Head and his co-workers. Dr. Boring considers that the results are best explained on the assumption that single sensory spots are innervated by more than one nerve-fibre and that the multiple innervation is projected upon the central nervous system as multiple excitations; he concludes that the sensory phenomena occurring during the return of cutaneous sensation can be accounted for on this hypothesis.

IN the *Psychological Review* (vol. xxiii., No. 4) Harvey Carr revives the problem of cutaneous sensitivity, as formulated by Rivers and Head in their well-known article of some years ago entitled "A Human Experiment in Nerve Division." The writer challenges the correctness of Head's theory, both from the point of view of the facts and of the interpretation of those facts. The nerve section, he maintains, produced an extremely abnormal condition of the cutaneous tissues, so that peculiarities of sensitivity were to be expected; hence it is not surprising that other investigators have failed to discover what Head calls the protopathic sensibility mediating four functions, and the epicritic mediating three. So far they have only been able to get evidence of the four sensory functions as formulated by earlier writers. Even, however, granting Head's evidence, Harvey Carr submits that the facts do not bear out the interpretation put upon them. He thinks that there is a too general tendency to accept enthusiastically and uncritically Head's theory. The article will prove interesting to many men of science, but particularly to physiologists and psychologists.

IN the Proceedings of the Physiological Society for July, Dr. Edridge-Green records the subjective phenomena produced by gazing steadily with one eye at a rotating cylinder of paper, half of which is black and half white. He finds that the centre of the field of vision appears to be in violent motion of a whirlpool character, and that the white part of the cylinder may appear green or rose-coloured according to the rate at which it is rotated. Dr. Edridge-Green explains these phenomena by supposing that the rods have the function of supplying visual purple to the cones, and thus increasing the sensitiveness of the latter to the light. The movement seen on gazing at the rotating cylinder is due to currents of photo-chemical liquid (visual purple) flowing towards the fovea in order to sensitise it.

IN Memoirs of the Geological Survey of New South Wales, Ethnological Series, No. 2, Mr. Etheridge, curator of the Australian Museum, Sydney, discusses the remarkable cylindro-conical and cornute stones found in the valley of the Darling. All kinds of explanations of their use have been given, some utilitarian, as, for instance, that they were employed as grinders, tombstones, records of the dead, challenge stones, or *bora* message stones; others magical, as used in rain-making and snake-producing, as death bone pointers, and so on. On the whole, it seems clear that they were used by the aborigines for some magical purpose, which may have varied among the different groups which possessed them. But the balance of evidence indicates that they were of a phallic type, and that they were used in some form of fertility rites.

CALCIUM carbonate in its crystalline forms gains further interest from a paper by Messrs. J. Johnston, H. E. Merwin, and E. D. Williamson (*Amer. Journ. Sci.*, vol. xli., 1916, p. 473). It is shown that the presence of calcium sulphate determines the precipitation of aragonite, a small quantity of the sulphate becoming associated in solid solution in the crystals. Aragonite has been thus obtained at as low a temperature as 19°. A form styled $\mu-CaCO_3$, in scales and hexagonal plates, has been obtained under conditions which are not fully determined. It has refractive indices between 1·550 and 1·650, a density of 2·54, and is unstable in the presence of nuclei of calcite or aragonite, which are less soluble. This form behaves like aragonite with Meigen's test. Useful warnings are given as to the use of this test in the case of mixed materials. Calcium carbonate hexahydrate ($CaCO_3.6H_2O$) is precipitated as monoclinic crystals at temperatures below about 20°; it can be preserved for months in isolated crystals in clove oil as a microscope preparation, but it changes rapidly at ordinary room temperature into calcite and water. The natural forms are carefully considered, and it is suggested that the preservation of aragonite in any but recent geological formations may depend upon its having been kept dry. It may be mentioned that this agrees with the observations of Horwood, Cole, and Little, who show that geologically old aragonite shells are preserved in clays rather than in limestones.

"THE Data of Geochemistry," by Mr. F. W. Clarke (U.S. Geological Survey, Bull. 616, 1916) now appears in its third edition, enlarged by some forty pages. The guarded discussion of Brun's results on volcanic gases in the edition of 1911 here receives important modifications; additional references are given to the problems of radio-activity; and even in the treatment of the deposition of carbonates by organisms new observations have been noted. It is remarkable how this book, embodying an enormous range of facts, and without a single illustration, retains its philosophic character and is readable throughout. We turn to it from the ordinary manual of petrography as we might turn from a stained-glass window to a conference with the cathedral founders.

THE peridotite with rhombic pyroxene that traverses gneiss in the Sierra de Ronda in Malaya proves to be the source of platinum in the sandy alluvium of the streams. This occurrence is contrasted by MM. L. Duparc and A. Grosset (*Mém. Soc. de physique et d'hist. nat. de Genève*, vol. xxxviii, 1916, p. 253) with the platiniferous dunite of Tagilsk in the Urals; the parent rock and its products of weathering are shown to resemble far more closely those of Khrebet Salatim, which lie farther north on the east flank of the Urals, and were discovered by M. Duparc in 1907. Maps are given of these three localities; the numerous small landscapes from the Ronda district have no great geological interest.

A VERY interesting and important paper by P. H. Gallé on the relation between fluctuations in the strength of the trade winds of the North Atlantic Ocean in summer and departures from the normal of the winter temperature in Europe appears in a recent issue of the Proceedings of the Amsterdam Royal Academy of Sciences. In a previous paper the author had shown that variations in the strength of the trade winds (15°–25° N., long. 25°–45° W.) were apparent two or three months later in some hydrographical phenomena in northern Europe. The subsequent variations in winter temperature have now been investigated. From an exhaustive comparison of various groups of months for the period 1899–1914 for combinations of five Dutch stations, three German stations, and three in the Far North-west, it was found that the largest correlation was obtained between the fluctuations of the trade wind for the six months May to October on one hand, and those in the temperature for the three winter months December to February following, on the other. The results, based on values computed for 135 stations, are graphically shown by iso-correlational lines on two charts which apply to the trade winds of May to October and of June to November respectively. For the first period the maximum positive value of r, 0·70, is obtained in East Germany, the largest negative, 0·60, in North Iceland and East Greenland. The largest correlation factor for any period was found in that part of Germany embracing the stations Berlin, Görlitz, Posen, and Ratibor, where the relation between the strength of the trade winds over the months June to November and the following winter temperature gave $r=0·85$ and $f=0·04$. By this method a successful prediction was made of the temperature over north-western Europe last winter.

THE Meteorological Office has issued a chart dealing with temperature scales which is evidently intended for the use of meteorological observers, but might with great advantage be suspended in every physical laboratory in the country. On the left-hand side of the chart the absolute, the Centigrade, and the Fahrenheit scales of temperature are drawn alongside each other from the absolute zero to 1500° A. of the absolute scale, the divisions being at 10° intervals on the absolute and Centigrade, and at 20° intervals on the Fahrenheit scale. A number of important thermometric points are indicated on the absolute scale, *e.g.* 4° A. helium boils; 43° A. oxygen melts; 90° A. oxygen boils; 234° A. mercury melts; 372·65° A. water boils under one-bar pressure; 505° A. tin melts; 717° A. sulphur boils; 800° A. bodies just red-hot, etc. On the right-hand side of the chart the three scales, from 180° to 330° on the absolute scale, are drawn together, the divisions on the absolute and Centigrade scales being one, and those on the Fahrenheit scale two degrees apart. A number of important meteorological temperatures are indicated—*e.g.* 219° A. the mean temperature of the stratosphere over England, 246° A. the lowest, and 311° A. the highest, temperature observed in the British Isles, etc. The strength of the solar heat stream is given as 135 milliwatts per sq. cm., but there is no indication as to where it has this particular strength.

IN the *Times Trade Supplement* for August Prof. H. E. Armstrong strongly urges that, without delay, concerted action should be taken for the complete association and organisation of all the interests connected with the manufacture of dye-stuffs. He argues that the Government has failed to appreciate the requirements of the situation, and has antagonised the interests concerned, and advocates the provision, in place of the body now ruling British Dyes, Ltd., which is described as incompetent, of a satisfactory joint management on which the fine chemical industry shall also be represented. Prof. Armstrong points out that five-sixths of the coal raised in this country is used direct, whilst the valuable volatile matters are conserved only from the remaining sixth. If the whole of the raw bituminous coal were coked at suitable temperatures, large quantities of liquid fuel suitable for use in internal combustion engines would be obtained; there would be a more than sufficient supply of the raw materials necessary for the manufacture of modern high explosives; the raw material for dyes would be more than enough to supply the whole world; large quantities of ammonia would be available for agricultural use; the volume of high-grade gas produced would be more than sufficient for domestic use; and by using the resulting soft coke the open fire could be retained with the advantage that soot and smoke would be abolished and less acid sent into the atmosphere. It has been stated that since the war began ten or more works for the carbonisation of coal at low temperatures (designed on the experience gained from experiments carried out in *this* country) have been erected in Germany, whilst our works are still in the course of erection. Prof. Armstrong urges that the Government should legislate forbidding the use of raw coal, and endorses the suggestion of the President of the Society of Chemical Industry that only the export of coke, not that of raw bituminous coal, should be allowed. Legislation is also necessary for the provision of funds for the study of all problems relating to the development of coking processes, the efficient use of fuels, and the utilisation of by-products. More than 600,000*l*. could be obtained annually for this purpose by placing a tax of only one halfpenny on each ton of coal raised. Not only would all the industries dependent on coal as a basis be developed as a result of such legislation, but our universities would be stimulated in the production of highly trained scientific workers, for whom there would then be a considerable demand.

CIRCULAR No. 19, issued by the Bureau of Standards, United States Department of Commerce, consists chiefly of a collection of standard density and volumetric tables issued in connection with the use of the hydrometer for industrial purposes or for the assessment of revenue duties. The confusion which had resulted from the employment of insufficiently defined hydrometer scales, and the lack of a uniform basis for the verification of standards, led the Bureau to investigate the problems connected with hydrometry, and to prepare standard density tables which would serve the purposes of accurate definition. The tables are set out clearly, so that there is no ambiguity as to their meaning or as to the bases on which the calculations are founded. In addition to the main particulars referring to aqueous solutions of ethyl and methyl alcohols, sulphuric acid, and cane sugar, various auxiliary tables are given, including temperature corrections, Baumé equivalents, and reduction of weighings in air to the corresponding values *in vacuo*. The inclusion of various physical constants, and of data for the computation of volumetric capacity from apparent weight of water-content, increases the usefulness of the compilation. A similar production adapted to British requirements might with advantage be made available for use in this country.

WE have received Technologic Paper No. 76 of the Bureau of Standards, U.S. Department of Commerce. It contains an account of experiments made upon the determination of the proportion of volatile "thinning" or diluent substances present in oil varnishes.

THE trajectory of a body falling freely *in vacuo* forms the subject of a paper by M. A. Viljev in the *Bul. Acad. Sci.*, Petrograd (May, 1916, pp. 643–671). After referring to the work of previous investigators he sums up the results of his own researches thus: 1. In dealing with this problem some authors have used inaccurate equations of motion, while others have not correctly defined the position of the vertical line. 2. A distinction must be made between the vertical line and the plane of the prime vertical at the upper point of the trajectory, corresponding to the initial position of the falling body, and the vertical line and plane of the prime vertical at the lower point of the trajectory, where the fall of the body ceases. At each point the vertical line is defined as passing through the initial position of the body perpendicular to the surface of the equipotential of the full force of gravity, produced through the given point. The plane of the meridian passes through the axis of the earth's rotation and the initial position of the body. The plane of the prime vertical passes through the vertical line as above defined and is perpendicular to the plane of the meridian. 3. On the basis of these definitions it is found that the body swerves from the plane of the prime vertical of the upper point of the trajectory slightly towards the pole. Relatively to the plane of the prime vertical of the lower point of the trajectory it swerves more towards the equator. 4. In falling in a shaft it swerves from the plane of the prime vertical of the upper point of the trajectory towards the equator. Also relatively to the plane of the prime vertical of the lower point of the trajectory it swerves towards the equator.

THE Royal Worcester Porcelain Company, Ltd., has sent us some specimens of its porcelain dishes and crucibles for chemical use. As is well known, before the war our chemical laboratories were entirely dependent on material of German origin. This Worcester porcelain has been examined by the National Physical Laboratory, which reports that in regard to all the qualities which can be examined in a short-period test the Royal Worcester laboratory ware is as good as the best laboratory ware hitherto employed, of which the Royal Berlin ware is a typical example. Details are given of the tests, which included the effect of strong sulphuric acid, and 10 per cent. solutions of caustic soda and sodium carbonate, the behaviour of the glaze at high temperatures, the constancy of weight of the dishes, and the resistance to sudden changes of temperature. As regards crucibles, thanks to the purely British industry in fused silica ware, we are almost independent of the quality of porcelain, but for basins porcelain is still essential. For these it is a vital point that material used in one experiment shall not be in part retained by the glaze and carried on to the next, and the National Physical Laboratory report would carry more conviction if greater attention had been paid to this matter. There was a slight *gain* in weight after the treatment with sulphuric acid, and on this the remark is made: "It has not been considered necessary to ascertain whether the increase in weight is due to combination between the sulphuric acid and the material of the glaze or to a slight penetration of the acid in the ware below the glaze." Time would have been better spent in developing this point than in high-temperature experiments, which, for dishes, were superfluous. The ware is made very much thinner than has been customary, and consequently is unduly fragile. In spite of careful packing two of the specimens arrived broken. It is very desirable that we should be independent of foreign supplies of porcelain, and it is to be hoped that the enterprise of the Royal Worcester Porcelain Company and other British porcelain manufacturers will be rewarded, but prolonged use in the laboratory is the only certain means of proving the qualities of the new ware.

MESSRS. WILLIAMS AND NORGATE announce "Raphael Meldola: Reminiscences by those who knew him," with a preface by Lord Moulton and a chronological list of Prof. Meldola's publications. The work will be divided as follows:—Biographical memoir; early years; professor of chemistry; chemical investigator; naturalist; astronomer; personality.

OUR ASTRONOMICAL COLUMN.

THE SOLAR PHYSICS OBSERVATORY.—The report of the director of the Solar Physics Observatory for the year ending March 31, 1916, has recently been issued, this being the third annual report since the transference of the observatory from South Kensington to Cambridge. The work of the observatory has been carried on with difficulty on account of the war, two members of the staff now being absent on military service and two on munition work. Observational work with the Newall telescope and the Huggins instruments was not attempted, but the spectroheliograph was in regular use, photographs of the sun's disc in K_{2-3-2} light having been obtained on 112 days, and of prominences at the limb on 93 days. Sun-spot spectra in the region λ 5300 to λ 5500 were also successfully photographed with the McClean installation. Mr. Baxandall has made considerable progress in the assignment of chemical origins of lines in stellar spectra, and in a revision of the origins given by Rowland for lines in the solar spectrum. The great majority of Rowland's identifications have been confirmed, and terrestrial equivalents for many lines not identified by Rowland have been found by reference to data subsequently published. Experimental work has established the identity of the G group of the solar spectrum with the hydrocarbon band λ 4314 (see NATURE, July 20), and it is thought that a clue has been obtained to the interpretation, in terms of carbon, of the remarkable spectrum of Comet Wells, 1882. In the department of meteorological physics, Mr. C. T. R. Wilson has continued the study of lightning discharges.

With regard to the "Annals of the Solar Physics Observatory," of which vol. iii., part 1, has already been distributed, it is now explained that vol. i. is intended to contain historical and descriptive matter, vol. ii. to refer to stellar investigations, and vol. iii. to deal with work on the sun.

RELATIVE LUMINOSITIES OF SUN AND STARS.—A convenient formula for comparing the luminosity of a star with that of the sun has been given by Mr. C. T. Whitmell (*L'Astronomie*, August, 1916). Assuming the stellar magnitude of the sun to be $-26{\cdot}5$, and designating the luminosity, parallax, and magnitude of the star by L, p, and m, the luminosity of the star in terms of that of the sun is given by the equation:

$$\log L = 0{\cdot}0289 - 2 \log p - 0{\cdot}4\ m.$$

In the case of Sirius, for example, where $p = 0{\cdot}38''$ and $m = -1{\cdot}6$, $\log L = 1{\cdot}5093$ and $L = 32{\cdot}3$, showing that Sirius is about 32 times as bright as our sun. The constant term in the equation depends upon the value assigned to the sun's stellar magnitude, and is equal to $10{\cdot}6289 + 0{\cdot}4(S)$, where S is the adopted value.

THE THERMOPILE IN PHOTOGRAPHIC PHOTOMETRY.—The usual method of arriving at the magnitudes of stars shown on photographs is to measure the diameters of the stellar images, or to determine the opacity of images purposely taken out of focus. In either case the result depends in part on the judgment of the observer, and the application of some purely physical method is evidently desirable. Such a method has been devised by Mr. H. T. Stetson, of the Yerkes Observatory, in which the star image is surrounded by a small circular diaphragm, and the intensity of the transmitted beam from a steady source of light, as compared with that of the unrestricted beam, is measured by means of a thermopile and galvanometer. Theory leads to the expectation of a fourth-root relation between galvanometer deflections and stellar magnitudes, and this has been confirmed experimentally. The device appears to have reached a convenient practical form, and measurements of a plate of the Pleiades, for example, indicated a probable error of 0·022 mag. for a single star. An extensive application of the method to the eclipsing variable U Cephei has been commenced, and variations not explained by the eclipse theory have been detected. When provided with a stage having a micrometer screw, and the circular aperture being replaced by a slit, the apparatus becomes well adapted for certain investigations of spectra. In this form it seems likely to be especially useful in the study of colour index, and may possibly aid in the determination of radial velocities of faint stars from objective prism plates taken through a neodymium absorption cell (*Astrophysical Journal*, vol. xliii., pp. 253 and 325).

RECENT INDIAN MUSEUM PUBLICATIONS.

THE latest serial publications of the Indian Museum reach a very high level of excellence. Vol. v., No. 3, of the Memoirs consists of Mr. Stanley Kemp's report on the Decapod crustacea of the Chilka Lake, an area where the density of the water ranges according to season between freshness and a saltness equal to that of the sea. The species, which number 54, include crabs, hermit-crabs, Thalassinids, Caridea, and Peneids. Among the permanent inhabitants, or species capable of withstanding every seasonal change in the water, from fresh to salt, it is surprising to find such characteristically marine forms as Leucosiid and Xanthid crabs, Alpheidæ, and the pelagic Lucifer. The permanent inhabitants constitute 72 per cent. of the whole. The seasonal immigrants (about 7·5 of the whole) all appear, whether normally marine or fresh-water species, to breed in the lake. The casual visitors (about 20 per cent.) are almost all from the sea. Among the 12 species described as new is *Athanas polymorphus*, the males of which are trimorphic. The report is a model of clear and critical exposition, being rich in inference and illustration, but always concise and explicit.

No. 1 of vol. vi. of the Memoirs contains two important papers, one on Indian Tunicata by Dr. Asajiro Oka, the other by Colonel J. Stephenson on Oriental earthworms. The first deals with simple Ascidians and pelagic forms, and does not go much outside the collections made by the *Investigator*. Perhaps the most interesting item is a full description of the extraordinary deep-sea genus Hexacrobylus, hitherto known but imperfectly from a single speciman discovered by the *Siboga* expedition, but now elucidated by five well-preserved specimens dredged by the *Investigator* from 1912 fathoms off Ceylon. In *Hexacrobylus indicus,* which the author regards as an aberrant Molgulid, the body is ovate and covered with delicate hairs; the branchial aperture is a wide transverse slit, ventral in position, and surrounded by six many-lobed tentacles, which collectively resemble thick, prominent, warty lips; the branchial siphon is nearly as large as the trunk itself; the branchial sac is scarcely distinguishable from the œsophagus, and is imperforate and destitute of stigmata, endostyle, and dorsal lamina; the gonads are symmetrically developed on both sides of the body, and the ovaries and testes have separate ducts: though differing from the *Siboga* species, it agrees with it in those features which separate it so widely from all other Ascidians. Another interesting new genus is Monobotryllus, which, though a simple Ascidian, is most closely related to some of the holosomatous compound Ascidians.

Colonel Stephenson's paper, which treats of Oligochæta collected mainly in southern India and Ceylon, though largely anatomical and systematic, is dignified by much instructive comparison and criticism. Twenty species and five varieties are described as new, among them a Pontodrilus from Ceylon remarkable in its habitat, far from the sea, at an elevation of 6200 to 7000 ft. Two new genera are defined, namely, Erythræodrilus from Bombay, apparently related to the Madagascar Howascolex; and Comarodrilus a Megascolecine from Cochin, in alliance with Woodwardia.

Part vi. of vol. xi. of the Records contains three papers of more than common interest. Dr. James Ritchie gives an exhaustive description of *Annulella gemmata,* a remarkable new Hydroid discovered by Dr. Annandale in a brackish pond at Port Canning in the Gangetic Delta. It is a minute form, solitary and usually attached, but also freely locomotive. Its attachment is by a "basal bulb," which alone is invested by perisarc, and is regarded as something between a basal disc and a hydrorhiza. Its tentacles, which are of extreme length, have the cnidoblasts concentrated in whorl-like rings, the cnidoblasts being almost identical with those of Hydra. The usual methods of propagation seem to be non-sexual, but Dr. Annandale, who kept specimens alive, states that minute medusæ are liberated. The non-sexual methods include longitudinal fission, transverse fission of the basal bulb, and the detachment of remarkable planula-like buds.

Dr. Annandale contributes an account, biological and systematic, of sponges parasitic on Indian Clionid sponges. Ten such parasites are reviewed, along with five Clionid hosts, the greater part of the collection being furnished by a few ounces of Madreporarian coral. The methods of attack and defence are discussed very fully. Among assumed methods of protection observed in certain Clionids inhabiting great depths, where the inorganic conditions of life may reasonably be supposed to be constant, is the production of gemmules.

Mr. F. H. Graveley's copious and well-ordered notes on the habits of insects and other Arthropods must be greatly commended. In addition to recording many original observations of behaviour, courtship, breeding, etc., particularly of that retiring group the Pedipalpi, the author has extracted references to multifarious observations published, mainly in Indian journals and in books relating to India, by other writers.

RECENT ECONOMIC ENTOMOLOGY.

THE economic importance of the Coccidæ ("mealy bugs" and scale-insects) is very great, especially in warm countries. It is satisfactory to see, therefore, the first part of an extensive monograph on the Coccidæ of South Africa, by C. K. Brain, published as part 2 of vol. v. of the Transactions Royal Soc. S. Africa (Cape Town, 1915). This contains a general introduction to the study of the family and detailed descriptions of the genera and species of the Pseudococcinæ, Ortheziinæ, Coccinæ, Monophlebinæ, and Margarodinæ. The systematic work has been done with great care, a notable feature being the charts demonstrating in the case of each species the range of variation in the lengths of the antennal segments; the illustrations—photographs and drawings—fill thirteen plates. The author has spared no pains to enlighten his readers, but it was scarcely necessary to include in his glossary the information that "ovum" means "an egg," and "transparent," "so clear as not to obstruct vision."

The *Bulletin of Entomological Research,* vol. vi., part 4, lately issued, contains, as usual, several noteworthy papers. Prof. G. H. F. Nuttall and Mr. C. Warburton describe briefly, with clear illustrations, thirty species of ticks from the Belgian Congo, and point out the importance of each as a carrier of disease. Mr. C. H. T. Townsend, of the U.S. Department of Agriculture, establishes—in reply to some recent sceptical criticism—that Phlebotomus is truly the infective carrier of the Verruga parasite. Dr. G. A. K. Marshall describes, with excellent figures, some weevils injurious to various cultivated plants in India. The highly useful *Review of Applied Entomology* has just commenced its fourth volume, and the first summary in the medical and veterinary series directs attention to the existence of the British and Irish sheep-fly (*Lucilia sericata*) as a pest in the southern United States, together with *Phormia regina,* on the authority of Messrs. F. C. Bishopp and E. W. Loake, in a paper published in the *Journ. Econ. Entom.,* vol. viii., No. 5.

Literature on the common house-fly continues to accumulate rapidly. Mr. R. H. Hutchinson (U.S. Dept. Agric., Bull. 345) contributes same interesting observations on the "Pre-oviposition Period" of the insect, with a view of estimating the value of fly-traps for reducing the numbers of eggs and larvæ. He finds that the term of the female's life before egg-laying varies from $2\frac{1}{2}$ to 23 days, "most of the records falling on the fourth, fifth, sixth, ninth, twelfth, and fourteenth days after emergence."

The larval trombidiid mites known as "harvest bugs" are too familiar as a well-nigh intolerable pest in some localities. Mr. Stanley Hirst (*Journ. Econ. Biol.,* vol. x., No. 4) gives a careful description of this larva under the name of *Microtrombidium autumnalis.* He also describes a Japanese species, *M. akamushi,* which carries the germ of a disease known as "river fever."

In a Technical Bulletin (No. 21) of the Michigan Agricultural College Experiment Station, Mr. Geo. D. Shafer continues the account of his investigations as to how "contact poisons" kill insects. Such gases as sulphuretted hydrogen, hydrocyanic acid, and the vapours of carbon disulphide, benzine, or paraffin affect insects when actually taken up by the tissues, where their presence seems to prevent oxygen assimilation. This result is due to the harmful effect of such gases and vapours on the enzyme-like bodies—reductases, catalases, and oxydases—which are functional in insect tissues. The contact poisons are believed to affect the activities of these enzymes to an unequal degree, thus disturbing their normal balance.

A paper of exceptional value and interest, on the morphology and biology of the green apple aphis (*A. posni*), is contributed by A. C. Baker and W. F. Turner to the Washington *Journal of Agricultural Research* (vol. v., No. 21). This is the "common apple aphid" in North America, as well as in these countries, and the whole life-cycle is passed on the apple. Very full and careful descriptions of the structure of the various forms are given by the authors, who, in the course of their season's work, examined no fewer than 75,000 specimens. Stages in the embryonic development are described, from which it appears that the embryo, after five days' growth, has a long resting period through the colder season of the year, lying in the centre of the winter egg. Of all the results obtained, however, the tracing of the succession through the spring and summer of a number of forms derived from a single stem-mother is the most important. Among the daughters of the stem-mother there may be one winged insect, and interesting "intermediates"—virgin females with rudimentary wings—appear together with the usual winged and wingless aphids. Sexual individuals may appear in the eleventh generation from the stem-mother, the earlier ones appearing as brothers and sisters of parthenogenetic females. The authors believe that temperature is by far the most important factor in determining the appearance of the sexual insects.

A paper by J. R. Malloch, on Chironomidæ and other Diptera from Illinois (Bull. Ill. State Lab. Nat. Hist., vol. xi., 4), is noteworthy because the systematic descriptions of the midges and flies are accompanied by detailed, well-illustrated accounts of the larvæ and pupæ of many genera of Mycetophilidæ, Asilidæ, Bombilidæ, Syrphidæ, and other families. G. H. C.

CHILIAN METEOROLOGY.[1]

ALTHOUGH Chile, in common with other South American countries, has suffered greatly from the conditions brought about by the European situation, the large budget of memoirs recently issued by Dr. Knocke shows little, if any, restriction in the work of the Central Meteorological and Geophysical Institute during 1915. No. 13, part i., of the Meteorological Year Book gives *in extenso* the tri-daily observations carried on at thirty stations during the year 1913, the data comprising barometric pressure, air temperature humidity, wind direction and force (the latter both in Beaufort and by anemometer), cloud, rainfall, evaporation, and exposed temperatures.

In No. 15, part ii., of the Meteorological Year Book the data are summarised in great detail from records kept at fifty-two stations, daily, monthly, and annual abstracts being given. As the stations cover more than 35° of latitude, and range in altitude from 4 to more than 3500 metres, all varieties of climate are to be found among the records. The warmest station, apart from Easter Island in the Pacific, was Arica, mean temperature 19·4° C. (66·9° F.), and the coldest Punta Arenas, 6·3° C. (43·3° F.). The absolute maximum was 38·3° C. (100·9° F.) at San Felipe, lat. 32° 40′ S., height 635 m., and the absolute minimum −8·0° C. (17·6° F.) at Punta Arenas. The effect of the cold Humboldt current in keeping down the temperature is well shown in the data for Arica (lat. 18½° S.) and San Felipe, the mean daily maximum values at the latter station on the mean of the year being 1·7° C. higher than at Arica, 14° nearer the equator, and situated at sea-level. A comparison of the temperature data from Ollagüe, at a height of 3695 metres, with those from Iquique shows a fall of 1° C. for each 323 m., both stations being close to lat. 20½° S.

Great variations in the mean amount of cloud are to be found, the mean annual values ranging from 0·9 at Calama in the north to 8·8 at Evangelistas, near the Pacific entrance to Magellan Straits. At the former station there were 327 clear days (cloud amount less than 2) and not a single cloudy day (cloud amount more than 8), while at Evangelistas only 2 days were clear and 305 cloudy. It is of interest to note that at the island of Juan Fernandez the barometric indications are very frequently an index of those taking place twenty-four hours later on the Chilian coast in about the same latitude.

No. 14 gives the daily rainfall recorded at 112 stations for the year 1913, arranged in parallel columns, thus exhibiting the distribution of the rain throughout the whole length of the country. The wettest station was Cape Raper, lat. 46° 49′ S., long. 75° 36′ W., with 4607 mm. (181·38 in.), the values for December being interpolated. At Calama and Copiapó in the north no rain fell, and ten other stations, all to the north of 30° S., had less than an inch. Hourly rainfall values are given *in extenso* for seven stations. From these records it is seen that torrential rains are uncommon, there being only two instances of more than an inch (25·4 mm.) falling in an hour, the maximum hourly fall being 40 mm. at Contulmo.

We are glad to see that in No. 16 Dr. Knocke continues to give hourly values of all the elements, the station selected in this instance being Los Andes, situated at the foot of Aconcagua, at a height of 820 metres, where the Chilian section of the Trans-andine railway begins. Los Andes enjoys an admirable climate—cool in summer and temperate in winter. Although 300 metres higher than Santiago, the mean temperature is slightly higher, while peaches and walnuts flower a fortnight earlier than in the Chilian capital. No. 17 of the memoirs contains the hourly values for the year 1914 of the principal climatic elements at Santiago, including earth temperature and the electric conductibility of the air observed once daily by means of a Wulff electroscope.

R. C. M.

[1] Instituto Central Meteorológico y Geofisico de Chile, Santiago, Dr. W. Knocke, Director. No. 13, "Anuario Meteorológico de Chile, 1913." Pp. 339. No. 14, "Medidas de agua caída en 1913." Pp. 71+plates. No. 15, "Anuario Meteorológico de Chile." Segunda parte. Pp. 134+plates. No. 16, "Valores horarios de los elementos meteorológicos en Los Andes, 1911 y 1912." Pp. 81+plates. No. 17, "Valores horarios de los elementos meteorológicos en Santiago, 1914." Pp. 91+plates.

THE MOVEMENTS OF THE EARTH'S POLE.[1]

MORE than a century ago it was shown by the mathematician Euler that if the axis round which the earth was rotating were not coincident with the axis of figure, which latter in the case of a spheroidally flattened earth is the shortest axis that can be drawn, the axis of rotation will revolve about the axis of figure in a period which, upon certain assumptions, can be precisely predicted. The time of one revolution of the pole of rotation around the pole of figure depends only upon the shape and degree of elasticity of the earth. In Euler's days the supposition that the solid earth had any appreciable elasticity was so far outside the range of experience that it was not considered by him. He calculated the period of the polar rotation on the assumption that the earth was perfectly rigid, and showed that this period would be about 305 days.

If we determine the latitude of a point on the

[1] Discourse delivered at the Royal Institution on Friday, May 19, by Col. E. H. Hills, C.M.G., F.R.S.

Earth—Rotation

earth's surface by observations of the stars, we are in effect measuring the angular distance between the axis of rotation of the earth and the vertical line, or line through the zenith, at the point of observation. If, now, this axis of rotation moves, the observed latitude of the place will change, and if we prolong the observations over a sufficient time, we ought to find that this observed latitude fluctuates backwards and forwards about a mean value with the same periodicity as that in which the earth's pole of rotation moves round the pole of figure.

Every observer who is engaged in making observations to determine the precise positions of the stars, a class of observation which up to a few years ago occupied a very large fraction of the time and energies of astronomers, is actually continually determining and redetermining the latitude of his instrument. There is thus an enormous mass of latitude observations available for examination, and it should prove a not too difficult task to analyse these with the object of detecting a periodic variation. Two causes, however, militated against success in this inquiry: first, the very small magnitude of this variation; and, secondly, the fact that the earth is by no means rigid, and hence that the true period of the precessional rotation differs very substantially from the Eulerian period of 305 days.

All the earlier attempts to find evidence of this variation were, in fact, hampered by this preconceived notion of the ten-month period; the observations were carefully scrutinised with the view of detecting it, a process, as we now see, foredoomed to failure. It would be a useless task to recount here the various attempts that were made. Two of these, however, I should not like to pass over without notice, those of C. A. F. Peters, at Pulkowa, and Clerk Maxwell in this country.

Peters in his great and classic memoir on the parallax of the fixed stars devoted one section to a discussion on the variability of the latitude in a ten-month period. He found that the actual variation derived from the observations was of so minute a magnitude that it was well within the limits of unavoidable sources of error, and he therefore concluded that if there was any separation of the two poles it was too small to be detected by observation.

Clerk Maxwell examined the Greenwich observations of Polaris in 1851–4, and thought he found some small indications of maxima at about ten-month intervals, but he considered the results as very doubtful, and that more observations would be required to establish the existence of so small a fluctuation.

Substantially the same result was derived by other inquirers. Astronomers were therefore satisfied, up to the year 1884, that the earth's axis of figure was so nearly coincident with its axis of rotation that the difference between the two was inappreciable to the most refined observations. All methods of observation and all principles of the reduction of observations, both of astronomers and of geodesists, were tacitly based upon the idea of absolute coincidence between the two axes.

In 1884 the subject was independently reopened by two men—Chandler in America, and Küstner at Bonn—and entirely fresh light was thrown upon it. Their work was simultaneous and quite independent. I will take Chandler's first.

In 1884–5 he took a thirteen-month series of observations at Harvard with an instrument of his own devising, to which I will revert later. These observations showed a progressive change in the derived latitude, which appeared to him of a greater magnitude than could be accounted for by any instrumental errors. He, however, hesitated to ascribe it to a real change in the latitude without further confirmatory observations, which he could not then make. He therefore put these observations aside, and was, six years later, drawn to re-examine them by the publication of some of Küstner's results, which were also only explicable on the hypothesis of an actual variation in the latitude of the place of observation. It was, however, quite obvious to Chandler that his series of observations contained no warrant for an Eulerian period of ten months, and he therefore, to quote his own words, "deliberately put aside all teachings of theory, because it seemed to me high time that the facts should be examined by a purely inductive process; that the nugatory results of all attempts to detect the existence of the Eulerian period probably arose from a defect of the theory itself, and that the entangled condition of the whole subject required that it should be examined afresh by processes unfettered by any preconceived notions whatever." This bold rejection of theory and appeal to observation alone was rewarded with immediate success, and Chandler was able to show that his observations of 1884–5 contained unmistakable evidence of the rotation of the one pole about the other in a period of, not 305 days, but 428 days. Wherein, then, lay the deficiency of Euler's investigation? As already hinted, this arose from the assumption of rigidity, and it was shown first by Newcomb, and afterwards, more completely, by Hough, that the 428-day period was fully in accord with a degree of elastic yielding of the earth quite consonant with probability. Hough showed that if the earth were as rigid as steel the period would become 440 days; that the actual period is somewhat shorter than this means that the earth as a whole is decidedly more rigid than steel, a result which accords perfectly with other known phenomena which depend upon the earth's elasticity, such as the rate of propagation of earthquake waves.

Immediately following on this initial success Chandler undertook a prolonged and most laborious examination of old observations and reached results which have not completely borne the test of subsequent review. He was confident that the whole movement of the pole might be explained as the superposition of two rotations, one circular, with a 428-day period, and one elliptical, with a period of a year. He thought, further, that there was evidence that the longer period had varied in past times, and that in 1770 it was less than a year. This last result was traversed by Newcomb, who showed its extreme improbability. While fully bearing in mind the lessons of past experience as to the unwisdom of relying too closely upon pure theory, we cannot resist the conclusion that to accept any large change in the 428-day period within recent years would be to set aside the whole dynamical justification for accepting this period as a reality, it being quite impossible to admit that the elastic constants of the earth can be subject to any appreciable alteration within such time as a century or so.

As regards an annual period, we should now prefer to say that, while there are doubtless seasonal transfers of material upon the earth, such as the accumulation and melting of Arctic ice, which may produce a movement of the pole with an approach to a yearly periodicity, the part of the movement due to a true annual period is very small, and is quite masked by large, irregular disturbances. We shall be on safe ground if we say that the observed polar motion is compounded of a precessional rotation in a period of something very near 428 days at an average distance of 20 ft. from the mean pole, with an irregular movement superimposed on it; this irregular movement having sometimes the effect of modifying the rate of precessional rotation and sometimes of changing its amplitude—that is to say, altering the distance between the pole of rotation and the mean pole—according as it is acting parallel to, perpendicular to, or at any intermediate angle to the direction of the precessional rotation. I shall revert to this question later, and show how it is possible by a simple graphical construction to separate out this irregular motion and construct a diagram of it which should be helpful in elucidating its cause.

While it is thus to Chandler that the credit of discovering the 428-day period should be ascribed, it is to Küstner that we owe the first real proof that there is an actual variation in the latitude of a point upon the earth.

Küstner's observations were made in the same years as Chandler's, 1884–5, and were designed to determine the constant of aberration, a class of observation identical with those which would be used to determine the latitude of the place. Upon reducing these observations the results were at first sight anomalous in that they gave an impossibly small value of the aberration constant. The anomaly was not due to any instrumental cause; it could not be due to any seasonal change in the refraction, as the morning observations of 1884 were not accordant with the morning observations of 1885, nor could it be explained by any possible error in the proper motions of the stars. Küstner was thus enabled to state positively that the latitude of the place of observation had actually changed. It must be admitted that the years 1884–5 were particularly favourable ones, and that both these astronomers were in a sense lucky in having chanced upon them. The movement of the pole happened at that time to be exceptionally rapid. I do not, however, mention this as detracting in any way from the merit of their achievements; they deserve to be remembered as simultaneous but independent discoverers of this important and interesting phenomenon, and should be honoured, Chandler especially for his courageous rejection of mathematical theory, and Küstner for the very high skill and exquisite refinement of his observational work.

The importance of Küstner's discovery was at once recognised upon the Continent, and a proposal was made to the International Geodetic Conference to establish a chain of stations for carrying on a series of simultaneous observations and thus deducing the true law of this latitude variation. The suggestion was soon carried into effect. Six stations were chosen, all at the same latitude, 39·1° N.—Carloforte, in an island close to Sardinia; Mizusawa, in Japan; Gaithersburg in Maryland, and Ukiah in California—all new stations, where special observatories had been built for the purpose; a new observatory, established by the Russian Government at Tschardjui, in Russian Asia; and the existing observatory at Cincinnati. The reason for selecting stations at the same latitude was that identical sets of stars could be observed at each place, and thus any errors due to defective knowledge of star places are similar for all. These began work in 1899. Later, two stations in the southern hemisphere, at latitude 31·5° S.—Bayswater in Western Australia, and d'Oncatwo in the Argentine—were added.

The results were reduced and discussed by Prof. Albrecht at the Geodetic Institute, Potsdam, and published with a diagram showing the actual polar movement as deduced from the mean of the observations at all the stations, from time to time.

It was not long before these observations yielded a result of the highest interest. The observatory which devoted itself most whole-heartedly to the work, and at which the observations were most extensive and most precise, is that in Japan. This was under the able direction of Prof. Kimura. By a searching discussion of the whole series of observations he showed that they became far more consistent if a new term were introduced into the expression for the latitude variation, this term having an annual period, but being independent of longitude and having the same value for all the stations at the same date.

It will be readily seen that this term differs completely from those we have been considering hitherto. It is not a shift of the earth's axis or a movement of the pole of rotation; as it affects all places along a parallel of latitude equally the pole evidently does not move, but something which has an effect exactly the same as if the centre of gravity of the earth were shifted a few feet up and down, northward and southward, from its mean position.

The great difficulty in elucidating the Kimura term lies in its extremely small magnitude and in the consideration that there are so many possible sources of error affecting observations of this class which might have annual periodicities that their separation and evaluation are extraordinarily complicated questions. This is not the place to attempt any complete discussion, but a mention of some of the lines along which a solution has been sought may detain us for a few minutes.

The magnitude of the term at the latitude of 39° is about 6/100ths of a second of arc, or 6 ft. on the earth's surface. It has the same value and phase for every station on the same parallel and is zero on about March 9 and September 12, and maximum and minimum on June 10 and December 10, *i.e.* about ten days before the equinoxes and solstices respectively. It cannot be accounted for as a real shift of the earth's centre of gravity. It is true that in the alternate melting and accumulation of ice and snow at the two poles we have a periodic factor at work which does do this, but the amount is far too small. It was pointed out long ago by Van de Sande Bakhuysen that to fit in with the observed value of this term the apparent path of the centre of gravity must have an amplitude of 3 metres, which, if translated into terms of polar ice, would mean that a cap of ice one kilometre thick and 244 square degrees in area would have to form and disappear each year. This is obviously quite impossible. There are certain possible errors in the accepted values of the proper motions and parallaxes of the fixed stars which might produce an apparent variation in the observed latitude of this nature. As all parallaxes are based upon differential measures we cannot with certainty say that such errors are impossible; we can only say that they appear to us very unlikely, and that, if they were actually proved to exist, our ideas of the stellar universe would be profoundly modified.

If there were a yearly term in the refraction which had the effect of a periodic change in the apparent zenith we should get a corresponding periodicity in the observations. If, for example, there were a solar atmosphere, even of a quite tenuous nature, which extended into space beyond the earth's orbit, we should get a seasonal change due to the varying angular distance of the sun from the zenith of the place of observation. An atmosphere which could bend rays of light to the requisite amount, though undoubtedly extremely rare, would, however, be dense enough to offer an amount of resistance to a planet, or *a fortiori* to a comet, inconsistent with observed facts. It is, however, quite possible that the changing declination of the sun may curve or tilt the mean isobaric surfaces in the upper atmosphere in such a way that the apparent zenith moves north and south about its mean value, and that it is to this cause we owe the greater part, if not the whole, of the Kimura term. Such a displacement of the isobars is highly probable, and the phase times of the latitude variation—nil at equinoxes, maximum northward at summer solstice, and maximum southward at winter solstice—fits in perfectly with this explanation. The observations made in the southern hemisphere should form a crucial test. If this is the true cause the apparent latitude of a southern observatory will be shifted in the same direction as that of its northern counterpart, *i.e.* northward in June and southward in December. We have only a short series of observations from southern stations, but so far as they go they appear to conform. There is thus fairly strong evidence in favour of this explanation.

It must not, however, be assumed that the matter is settled beyond dispute. More observations are necessary, and especially observations at widely different latitudes. The international stations are, as to the northern ones, almost exactly on a parallel, and, as to the southern ones, on a parallel differing only by $7\frac{1}{2}°$ from the northern. This uniformity, highly advantageous for securing a precise record of the motion of the earth's pole, is disadvantageous for solving the riddle of the Kimura variation, and other places should join in the attack. Unfortunately the observations are very laborious and require the almost exclusive attention of an observer. There is, therefore, a very real want of an instrument which shall demand something short of the whole time of a skilled astronomer. With this object, and also with the intention of eliminating certain sources of error, instruments of new form have been devised. A short account of these will be of interest.

I shall not here attempt any description of the methods of observation used. It will be sufficient to say that, as what we want to find is the direction of the zenith at the place, all methods ultimately depend either upon a level, giving us the horizontal plane, or upon a plumb-line, giving us the vertical, and that of these two the level is the one that has almost exclusively been employed by the astronomer. The level is an instrument capable of a high degree of precision, but it has the disadvantage of being very susceptible to temperature changes, and, as both the glass tube of the level and the spirit with which it is filled are bad conductors of heat, it is impossible to ensure that it is at an even temperature throughout. Irregularities are thus produced which the reading of both ends of the bubble only partially eliminates. The mere fact of an observer standing near a sensitive level to read it may seriously vitiate its accuracy.

Some of these errors may be avoided, and such errors as are due to faulty reading of the level graduations by the observer entirely eliminated, by making the level an integral part of the instrument by floating the whole in liquid. The first application of this principle to an astronomical instrument was by Chandler, who carried out his series of latitude observations, already mentioned, with an almucantar, being a transit telescope floated in a trough of mercury. The name "almucantar" means a small circle of the heavens parallel to the horizon, and it will be sufficiently obvious that if the telescope can be set at any angle with the float, then as the instrument is rotated in the trough, or the whole trough itself is turned, the line of sight of the telescope will move round such a circle. With this instrument the stars are observed, not as in a transit circle crossing a vertical line, but crossing a horizontal circle of constant altitude. For convenience of calculation this horizontal circle would generally be selected as that through the celestial pole at the place. Chandler's instrument was purposely designed so as to differ as little as possible from the ordinary visual type, and must have been a most difficult instrument to use. The fact that he got such excellent results from it is no small tribute to his manipulative skill. The use of this form of instrument cannot be said to have found great favour among astronomers; there is only one example of it in this country, and, so far as I know, none on the Continent. The one we have is at the Durham University Observatory, and was designed by the present Astronomer Royal for Scotland, in co-operation with the late Dr. Common. It marked a very decided advance upon the earlier type. In two points specially, the screen of the floating part from wind disturbance, and the attachment of the eyepiece to the fixed part, the designers had the idea of a movable instrument, which a slight touch or a puff of wind would set vibrating to such an extent that no observation would be possible for a minute or two, clearly before them. The almucantar method of observation, meaning by this, not the use of a floating type of instrument, but the observing of stars crossing a horizontal circle, though appropriate for the particular class of observation we are here concerned with, those for determination of latitude, is not absolutely the best that can be used. To reduce every possible source of error to a minimum, particularly those due to refraction of the atmosphere, we want to observe stars as near the zenith as possible.

The floating principle has been applied with great success to a zenith instrument in the Cookson floating zenith telescope now at Greenwich, designed by the late Bryan Cookson, whose early death was a great loss to astronomy.

It is a photographic instrument, with a telescope or camera tube attached to a circular float which floats in a ring-shaped trough of mercury. The angle between telescope and float can be altered so that it can be clamped to point either vertically upwards or at any angle, up to about 30°, from the vertical. It is used in the well-known Talcott method. A pair of stars is selected which cross the meridian within a few minutes of each other at nearly the same zenith distance, one north and one south of the zenith. The instrument is set so as to include the first star in the field, the lens is opened, and as the image of the star moves across the plate it traces a fine line or trail. After the star has crossed the meridian, the telescope is turned through 180°, leaving tube and float clamped in the same relative position, and the second star traces out its trail. The distance between the two trails on the plate, which is small if the difference of their zenith distances is small, when the appropriate corrections are applied, gives the observed difference of zenith distance of the two stars, and, therefore, the observed position of the zenith, and hence the latitude of the observer. By repeating the observation with a number of pairs of stars a very precise determination of the latitude is made.

Recently a zenith telescope, designed, not on the floating, but on the hanging principle, finding the vertical line by virtue of its free suspension in a gimbal ring, has been constructed, and would have been at work by now had it not been for the interruption caused by the war. Though it has thus not yet been tested by practical experience, a few words on it may not be out of place. The method of observation will be the same as I have just described, except that there is no arrangement for clamping the instrument at an inclination to the vertical; it is intended to be used only in the vertical position, and the angle covered by the photographic plate will be a few degrees from the zenith on each side. Exactly how far we can go from the zenith depends upon the qualities of the lens, and no confident statement can be made until this has been tested, but it is hoped that star trails perfectly sharp for measurement will be secured up to an angular distance of 3° from the centre. This gives us as available for our purpose the stars over a belt 6° wide down to the sixth, and possibly the seventh, magnitude. The actual work of observing will be very simple, and will only mean that the whole instrument is rotated through 180° at certain prearranged times, and that the lens is opened after twilight and covered before the dawn. It would be possible for this to be done by mechanism controlled by a clock.

As the telescope hangs freely always in a vertical position, we entirely get rid of one of the astronomer's anxieties, the risk of error due to flexure or bending of his telescope, for though the tube can be made apparently very rigid, the excessively minute degree of bending sufficient to introduce appreciable errors is difficult, if not impossible, to avoid in a telescope which has to be used in different positions. Then, again, the errors due to changes of temperature inside or close to the instrument should almost disappear in this form. First, no temperature changes affect the suspension; so long as the body of the telescope remains undistorted the position of the true vertical in regard to the optical axis remains constant. Secondly, as the whole hanging part of the instrument is perfectly symmetrical about the vertical axis, with the trifling exception that the plate-carrier and photographic plate are not circular, but rectangular, no temperature change should distort the axis. Any distortion that can take place will, in fact, be the very small change of scale that will result from the difference in the expansion of the glass plate and the brass tube. Thirdly, it is possible, and in this instrument has been done, to enclose the whole in an outer case which can be made air-tight and kept at a constant temperature by a thermostat. In order to close the instrument in front it is necessary to have a plane parallel glass of slightly larger aperture than the lens. As this glass has to be worked with the same refinement as a lens, and as a plane surface is more troublesome to work than a curved one, this is rather a costly addition. Whether, as a matter of fact, it is worth while keeping the instrument at the same temperature, or whether it will be better to reduce the temperature change to a minimum by covering the whole with non-conducting material, and then apply the very small corrections necessary to the measurements made on the plate, is a question for experience to decide.

As a heavy hanging mass would be liable to long-continued vibrations when disturbed, a four-armed

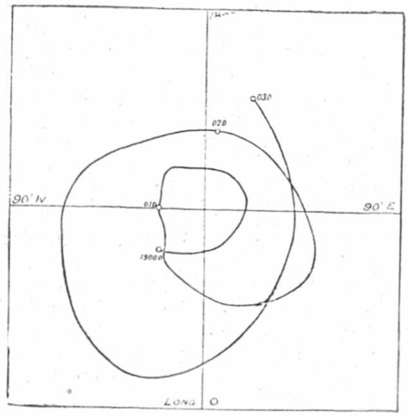

FIG. 1.—Track of polar movement, 1900–3.

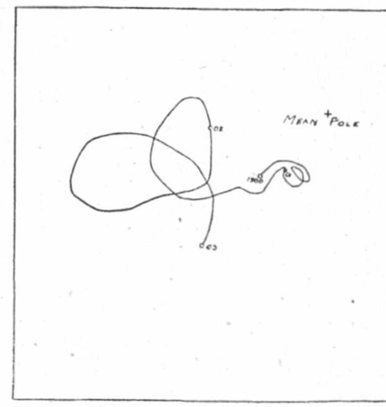

FIG. 2.—Same track referred to axis rotating in the earth with a fourteen-month period.

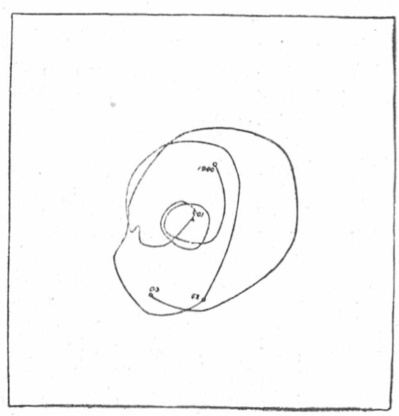

FIG. 3.—Hodograph of Fig. 2.

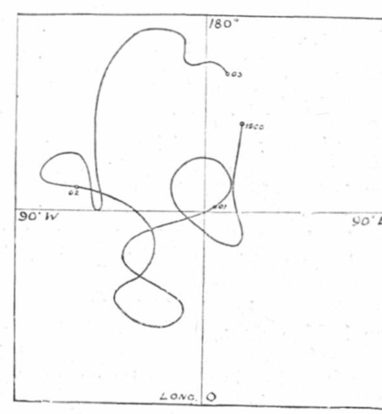

FIG. 4.—Hodograph referred back to axes fixed in the earth, or torque diagram.

vane attached to a rod at the base is immersed in a dash-pot or bath of glycerine. This rod must be centred in prolongation of the vertical axis, otherwise the capillarity between rod and liquid will introduce a force deflecting the telescope from the true vertical. While it would thus appear that in this form of instrument most of the familiar sources of error are minimised, it is interesting to note the introduction of one possible cause of error, quite unfamiliar to astronomers, namely, the deflection that might be due to the attraction of the earth's horizontal magnetic force upon the hanging part. If the telescope-tube were, as is customary, made of iron or steel, this would reach a serious magnitude, and even if a proportion only of the suspended weight were of iron a perceptible deviation might result. It would, in fact, not be safe to allow this proportion to exceed one-tenth of the whole weight, and it therefore seemed better to exclude the use of iron or steel altogether. There is accordingly none, with the exception of the four thin flat pendulum springs which form the gimbal suspension.

In detaining you with these short descriptions of recently devised instruments, I may appear to have been wandering rather far from my subject, the wanderings of the earth's pole. You will, however, appreciate that in reality they follow very closely from it, being instruments designed with the special object of solving the particular problem we are discussing.

We will now revert to the diagram of the observed polar motion, and I will indicate how it is possible to analyse this so as to separate the irregular movements from the more orderly fourteen-month precessional rotation. We are justified in assuming that this free precessional period is constant in duration and therefore determines the average rate of rotation of the pole of revolution. If, therefore, we take a diagram of the polar movement, which will naturally have its axes of reference fixed in relation to the earth, and convert it into another diagram, showing the same movement, referred to axes rotating in the earth at the average rate of the precessional rotation, we obtain a graph of the irregular part of the polar path. If this irregular part has any well-marked annual period, such period ought to be apparent on inspection of the converted diagram. In the actual diagrams obtained there seems little or no evidence of the existence of a yearly term.

We now take the second diagram, and by the well-known process construct its hodograph, the curve which gives us a measure of the amount and direction of the force which could have caused the movement recorded in diagram No. 2. This will still be referred to the moving axes, so is not directly available for deducing the true direction of these forces in the earth. Before we can do this we must refer the diagram back again to axes fixed in the earth. Thus, finally, we obtain our diagram No. 4, which may be called the torque diagram, as it represents in direction and relative magnitude the torque or twisting force which has been acting upon the earth to produce the observed movement of the pole.

The interpretation of such a diagram is a somewhat complex matter, and has not yet advanced far. The causes that seem to be at work producing the irregular shift are either movements of the earth's crust, slow or rapid, as in an earthquake; the transfer of Arctic ice from one point to another, or its accumulation and disappearance so far as this takes place unsymmetrically with respect to the earth's axis; and possibly extensive barometric changes extending over considerable areas.

Of these the transfer of ice is the largest factor and is probably the one to which most of the irregular polar movement may be ascribed. An earthquake, even of gigantic dimensions, would have an almost negligible effect. The late Prof. Milne estimated that a very large earthquake might displace ten million cubic miles of earth through a distance of 10 ft. horizontally or vertically. Such a vast cataclysm would only change the position of the pole by a few inches.

In conclusion it will be an act of natural curiosity to inquire whether there is any evidence of the amplitude of these polar wanderings having been greater in past times than at present, and whether there is any likelihood of their being greater in the future. To both these questions the answer is "No." The axis of rotation is always kept near the axis of figure by internal friction, and it would require a large change in the distribution of mass to move the axis of figure very far.

As regards the future, the probabilities point still more strongly in the same direction. Each shrinkage of the earth, whatever its immediate effect on the position of the axis of rotation may be, tends ultimately to bring it nearer to the axis of figure or principal axis of inertia, and therefore tends to reduce the average amplitude of the polar path. The distance of the pole of rotation from the mean pole will therefore gradually decrease as the world grows older, while at the same time, as the earth cools and becomes less elastic and more rigid, the rate of rotation will quicken.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Marquess of Crewe has been appointed President of the Board of Education, in succession to Mr. Arthur Henderson, resigned.

THE honorary degree of doctor of laws has been conferred upon Dr. Otto Klotz, of the Dominion Astronomical Observatory, Ottawa, by the University of Pittsburgh.

AN explanatory circular respecting the programme for technical schools and classes for the session 1916–17 has been issued by the Department of Agriculture and Technical Instruction for Ireland. The regulations which were in operation during the session 1915–16 will continue in force with some few alterations, among which we note that a school will not be recognised as a technical school under the conditions of section ii. (*a*) of the programme unless there are at least twenty approved introductory and specialised course students in attendance in any session, of whom not less than 50 per cent. are specialised course students. Teachers recognised for grants under the conditions of the third paragraph of the explanatory circular will not be recognised for this purpose as specialised course students. The case of schools of a special character will receive special consideration, and, if it is thought desirable, this regulation may be modified in the case of such schools. Grants will not be paid upon the attendance of a student at more than one lesson in the same syllabus on the same day, unless there is an interval of at least 15 min. between each lesson. Instruction in the first-year syllabus of a subject of a specialised course will not be permitted to be given concurrently by the same teacher with instruction in any other syllabus or subject.

A REPORT on Indian education, 1914–15, by Mr. Sharp, educational commissioner with the Government of India, has recently been received. The report is a very brief narrative of the main lines of Indian educational progress, and consists of twenty-seven pages (quarto) of letterpress and fifty-seven pages of tables. In addition, something like fifty interesting illustrations are given of educational buildings of different grades and classes which have been completed during the twelve months under review, and of the arrangements in such buildings. When it is considered that all forms of education are dealt with, from university standards down to primary schools, with an area about fifteen times as large as the United Kingdom, with a number of pupils of between seven and eight millions, and at a cost of eleven crores of rupees (that is, more than 7,200,000*l.*), it will be understood that a volume of the size mentioned represents almost the utmost limits of condensation. The effects of the war in Europe have been very distinctly felt in India, in the first place, in the desirability for economy, though even here it was found that the expenditure for the year under review was about 90 lakhs (nearly 600,000*l.*) higher than in the year previous to the war. The increase appears to have been mainly due to the rapidly increasing number of pupils in the schools, etc.; for in the five years up to 1914 the numbers had increased by no fewer than one and a third million pupils. The war, however, has affected the higher educational institutions more than the lower, for a good many of the British professors in colleges, etc., are now on military service. It is noticeable that pamphlets, such as "Why Britain is at War" and others, have been widely distributed in several of the Indian vernaculars to pupils. Also other means, such as lectures, etc., have been taken to put the war in its proper light. On the other hand, though it was known that Germany had long maintained a regular organisation of propagandist schools throughout the world, it was not until July, 1915, that steps were taken by the Government of India to intern or repatriate the enemy aliens in India who were engaged in school work, when such schools were handed over to other agencies.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 7.—M. Paul Appell in the chair. C. **Richet**: The monthly variation of natality. For a period of fifty-seven years the maximum number of births is in February or March. For the years 1906–10 the maximum in these two months is shown in all countries in the Northern Hemisphere, and figures for eleven countries are cited. In the Southern Hemisphere the monthly maximum is in August–October, or a period six months from the maximum in the Northern Hemisphere. The maxima are in the same months both for legitimate and illegitimate births, for rural and urban populations, for the poor and rich; but a relation can be traced between the latitude and the date of the monthly maximum.—C. **Camichel**: Hammering in water mains: the examination of the state of a main. P. **Choffat**: The volcanic intrusive rocks of the region situated to the north of the Tagus.—E. **Belot**: Experimental volcanoes and the laws of volcanic phenomena. The experimental arrangement described in an earlier communication can be modified by the introduction of a layer impermeable to water and steam (slate) above the source of heat.—R. **Souèges**: The first divisions of the egg, and the origin of the hypophysis in *Capsella bursa-pastoris*.

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Le Climat de la France: Température, Pression, Vents. By G. Bigourdan. Pp. 135. (Paris: Gauthier-Villars et Cie.) 4 francs.

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The Sea-Trout. By H. Lamond. Pp. xi+219. (London: Sherratt and Hughes.) 21*s*. net.

Observations made at the Royal Magnetical and Meteorological Observatory at Batavia. Vol. xxxv. (1912.) Pp. xxvi+96. Observations made at Secondary Stations in Netherlands East-India. Vol. iii. (1913.) Pp. ix+119. (Batavia: Government Printing Office.)

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