THURSDAY, OCTOBER 8, 1908.

SUPERHEATERS.

Superheat, Superheating, and their Control. By William H. Booth. Pp. xv+155. (London: A. Constable and Co., Ltd., 1907.) Price 6s. net.

THE constant reiteration of one maker's name in the book before us is wearisome, and we are agreed that "Connected as the author is with the only type of superheater using water-control in inner tubes he is not unnaturally apt to favour that system somewhat" (p. 143). He does this to the extent of twenty-two full pages of illustrations, &c., out of the 155 composing the book, besides further references on nine more!

The author thinks regulation of the temperature of the steam most important, and mentions seven ways of accomplishing this end. Prof. Unwin, however, has expressed scepticism as to this necessity "*provided only the superheaters were properly placed*"; an opinion in which he was supported by the late Mr. Bryan Donkin.[1]

The author considers Lancashire and similar boilers suitable for combining with superheaters, but for "average water-tube boilers," whatever this may mean, and marine boilers he recommends separately fired superheaters.

The inventor of one of the most widely used superheaters, especially for locomotive work, is referred to as "one Schmidt," and *two* locomotives are stated to have been fitted with his system with good results! While crediting another system with having been fitted or ordered for 372 locomotives, he gives no description. Describing another in some detail, he says nothing of its performance, or, indeed, whether it is in use. Only two other superheaters are illustrated. Particulars of two tests only are given, made with "Cruse" and "Foster" superheaters respectively.

Although he works out the area of a "theoretical diagram" to one ten-thousandth of a square inch (!) the author is less particular about other matters. For instance, the specific heats of several of the substances in a table on p. 8 do not agree with those on p. 148. In a curious calculation on p. 16 he concludes that a pound of steam at 361° F. will raise 60 pounds of cast iron from 62° to 361°. Taking the value of the specific heat of cast iron =0·11, as given on this page (two other values are given elsewhere), 1973 B.Th.U.[2] are required to effect this. As each pound of steam can only supply 1192 B.Th.U., even if cooled to 32°, the author expects to get more heat out of the steam than it contains.

In attacking what he calls "The Leakage School" he is apparently unaware that serious leakage is usually only attributed to engines with flat slide valves; and not, therefore, to those designed for use with superheated steam. Captain Sankey has demonstrated in a masterly manner that properly designed piston valves are practically steam-tight.

On p. 29 the well-known expression $PV^{1·065}$ is printed $PS^{1·065}$; an unfortunate departure, as "S" has another meaning on p. 33. Another loose expression is the use of the term "thermometric" heat for a quantity measured in B.Th.U.

On p. 34, the first equation is hopelessly wrong. A formula at the bottom of the same page, for converting the actual evaporation of a boiler to its equivalent weight of water "from and at 212," is only correct if the steam is saturated and dry; yet we read on p. 46 "No boiler delivers dry steam."

Notwithstanding the author's statement that he "prefers not to write a book of the catalogue-compilation type," he has, in our opinion, failed to give any information which would be useful to a designer, or, indeed, to anyone but a prospective customer.

The publishers have produced the book in their usual excellent style, but there are one or two instances of American spelling which have apparently escaped the reader's notice.

1 Proc. Inst. Mech. Engineers, 1896.

2 $(0·361^{\circ} - 62^{\circ}) \times 0·11 \times 60 = 1973$.

A BAVARIAN TEXT-BOOK OF BOTANY.

Lehrbuch der Botanik für Oberrealschulen und Realschulen. By Dr. Th. Bokorny. I. Teil. Pp. vi+366. Price 4 marks. II. Teil. Pp. 223. Price 3 marks. (Leipzig: W. Engelmann, 1908.)

A REDEEMING feature of the large number of botanical text-books published during the last few years has been the freshness, in some cases the originality, of treatment which has from time to time characterised them. The volumes now under notice constitute a case in point. The reorganisation and extension of botanical teaching in the Realschulen and Oberrealschulen of Bavaria has rendered the existing text-books unsuited to the changed ideas, and in the present volumes Prof. Bokorny has produced a text-book which aims at directing, upon right lines, the efforts of those entrusted with the new teaching.

The author's treatment of his subject is of some interest to teaching botanists. The first section of part i., occupying nearly one-half of the volume, is concerned with a description, in almost non-technical but very direct language, of representative plant species from the phanerogams downwards, the flowering plants receiving by far the greatest attention. At convenient intervals in these descriptions the author deals with a topic of special interest—not necessarily bearing upon the preceding subject-matter—particular examples being the influence of soil conditions upon plant life, the relationships between plants and insects in the pollination processes, distribution of fruits and seeds, and the influence of light upon plant growth. An almost inevitable accompaniment of this system is a certain discontinuity of text which is occasionally striking, but there can be little doubt that the method should quickly arouse the interest of the student, and found it, from the beginning, upon an extended basis. The plants chosen for description are invariably such as should be familiar to students who are no longer beginners, and a welcome departure from established custom is the inclusion of plants of economic importance. The descriptions are largely concerned with floral characters, and are brief and well-written.

The first section of the book, together with an out-line of the essential points of plant anatomy and histology, may be regarded as preparatory to the more serious systematic study of the vegetable kingdom contained in section iii. As might be expected, Prof. Bokorny has adopted the Englerian scheme of classification, but reference is made to other systems, the Linnean system being considered, in a special chapter, at greater length perhaps than is desirable at the present day. The greater part of the section is devoted to the principal orders of phanerogams; and in his emphasis of well-chosen points of taxonomic importance and frequent references to plants of economic and biological interest, the author has produced a very clear and readable exposition of a branch of botany notoriously difficult to deal with in a manner which shall arouse and, more especially, sustain the interest of the student.

The question of general morphology is dealt with in the first section of part ii. Both the stage at which this important branch of botany is considered and the relatively small amount of space allotted to it—some twenty pages largely occupied by illustrations—would probably meet with criticism at the hands of most English botanists, and the same may be said with regard to the comparatively little attention paid to anatomy. But the principal features of part ii. are the sections dealing with physiology and ecology. In the latter section the author prefers the primary title of "Biologie der Pflanzen"; the various factors influencing plant life are first considered in some detail, and the actual studies of typical formations are concerned with the vegetation of the earth as a whole rather than with a detailed consideration of more restricted areas, a method more generally adopted in this country.

A feature of the book is the wealth of illustrations with which it is provided. Most of them are familiar friends, but they are drawn from very varied sources, and the inclusion of many of them is a further example of the freshness of conception which has been already commented upon as characterising these volumes.

OUR BOOK SHELF.

Dœmringen i Norge. By Prof. H. Mohn. Pp. 76. (Christiania: Jacob Dybwad, 1908.)

In a country which stretches, as Dr. Mohn reminds us, to the 71st degree of north latitude, the times of sunrise and sunset, with the accompanying phenomena of twilight, have a wider significance than with us. There the calendar has to be consulted to find the day when the sun will first appear above the horizon, while the amount of light received when the sun is a definite distance below the horizon has a distinct economic value. Even the azimuth at which the sun will rise or set is not altogether a negligible quantity. Considerations of this kind have led Prof. Mohn to submit the question of twilight to a very close investigation, and to furnish tables which will enable an inhabitant of these northern regions to gauge very accurately how much direct or reflected sunlight he may expect. No doubt Prof. Mohn is well advised from a practical point of view, but in some respects his tables seem to aim at a greater degree of accuracy than can be of service. In such questions as the effect of temperature on refraction, or the amount of reflected light, the variables arising from clouds and state of the sky generally would upset the nicety of the calculations. But so far as the convenience of the tables is concerned, and the thoroughness with which the theory is presented, there is nothing left to be desired, and it is not surprising if those who have not lived in a country where the economy of the winter light is a matter of importance fail to appreciate the necessity of this accuracy.

Prof. Mohn recognises four distinct steps in the approach of night or dawn. (1) The true time of geometrical sunrise or sunset when the sun's upper limb is on the astronomical horizon, or $Z_1 = 90° + r - \pi + \rho$, where ρ is the refraction, r the sun's radius, and π the parallax. (2) The beginning and end of the gloaming (Skumringens Ende), when the sun's centre is 4° below the horizon. In clear weather in Norway, indoor work is possible under these conditions. Bright stars begin to appear in the sky. Sirius is visible when the sun is three degrees below the horizon. (3) It is more difficult to understand what is meant by the end of twilight. It is the time when daylight decreases most rapidly, and is described as the time when, in a clear sky, print can be read with difficulty if the light from the illuminated part of the sky is allowed to fall on the page, or when some kinds of outside work may be carried on. As a matter of computation, the time is decided by increasing the zenith distance of the sun, given in the first case by small angles depending on the atmospheric refraction, making the sun's zenith distance about 98°. (4) The last stage is that of complete night, or the time when the earth's atmosphere receives no light from the sun. The sun is then about 17° below the horizon. This scheme is a great practical advance on the method adopted in this country, where an arbitrary zenith distance of 108° is accepted as that at which night begins or ends. Tables are given for extending the calculations to other latitudes, and would make them available in the Shetland Isles and North Scotland.

Maryland Weather Service. Vol. ii. 1907. Pp. 515; illustrated. (Baltimore: The Johns Hopkins Press, 1907.)

This volume contains a report on the climate and weather of Baltimore and vicinity, prepared by Dr. O. L. Fassig under the direction of Prof. W. L. Moore, chief of the United States Weather Bureau; it is based on observations of the latter service since 1871, supplemented by all available records, both public and private, extending over a period of nearly a century. Meteorologists owe a debt of gratitude to the board of control of the Maryland Weather Service, and to Dr. Fassig especially, for one of the most complete and valuable meteorological discussions extant. Part i., which occupies more than half the volume, deals with climatic factors, each element being considered, so far as possible, with reference to its annual and diurnal periods and its variability; the statistical tables are supplemented by the usual range diagrams and also by isopleths, the principle of which was devised many years ago by M. Léon Lalanne. Although not frequently employed, the latter method exhibits in a concise and intelligent way the successive changes throughout the year. The value of this section of the work is much enhanced by careful discussion of the results obtained and of the interaction of the various elements, by references to the present state of our knowledge and to generally accepted theories.

Part ii. deals with actual weather conditions, with cold and warm waves, and types of weather, illustrated by beautifully executed synchronous charts. The discussions, which will be of the utmost interest to the students of practical meteorology, direct especial attention to the relation between wind-direction and temperature, the distribution of clouds, rainfall, &c. The author makes use of the long series of data at his disposal to test several points of popular interest. The temperature observations, extending over a period of eighty-seven years, do not exhibit any tendency to the cold period about May 10–13 which is observed in Europe; on the contrary, there is a distinct rise, probably due to high barometric pressure at this time over the southern Atlantic States. Nor do they show any regular recurrence of cold and warm periods; the only negative conclusion that the author considers may be safely drawn is that a cold winter is not likely to be followed by a warm spring or summer, and that a warm winter is not likely to be followed by a cold spring or summer. The observations clearly disprove the popular belief in the occurrence of severe storms at the equinoctial periods of March and September, while a comparison of weather conditions with the sun-spot curves neither proves nor disproves any intimate relation. We congratulate the author on the able way in which he has dealt with the whole subject, without having had recourse to mathematical formulæ.

A Monograph of the Silurian and Devonian Corals of New South Wales. Part ii. By R. Etheridge, jun. (Sydney, 1907.)

THIS part deals with the genus Tryplasma, of which several new species are described, from the Upper Silurian of the neighbourhood of Yass. A history of the genus is given, together with an account of its relations to other genera and its systematic position. Attention is directed to the intimate relation existing between the structure of Lindström's Pholidophyllum and that of Tryplasma, but in none of the Australian species of the latter have been found any of the exothecal scales which led Lindström to consider *Pholidophyllum tubulatum* (Schloth.) homologous in a certain sense with Calceola, Goniophyllum, and Rhizophyllum. The author advocates the removal of *Ph. tubulatum*, as a representative Tryplasma, from the vicinity of the *Anthozoa operculata* to a separate family, the Tryplasmidæ, with relations to Amplexus and Pycnostylus. The general structure of the Australian Tryplasmidæ is described in detail, but the examination of the development of the septal lamellæ and spines by means of serial sections was not attempted.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by Lt.-Col. C. T. Bingham. Rhynchota. Vol. iv., part ii. Homoptera and Appendix (Part i.) By W. L. Distant. (London: Taylor and Francis, 1908.) Price 10*s*.

WE congratulate the editor and author on the appearance of another half-volume of this important work. The present instalment is devoted to the homopterous family Jassidæ, subfam. v. Jassinæ (including Acocephalinæ), comprising twelve divisions, and subfam. Typhlocybinæ, with two divisions. The species included are numbered from 2509 to 2696. An appendix is commenced, including additions to the Rhynchota Heteroptera discussed in vol. i.; and the portion now published relates to the families Pentatomidæ, Coreidæ, and Berytidæ, and the additional species are numbered from 2697 to 2768. The general character of "The Fauna of British India" is so well known, and has been so frequently commented on, that it is only necessary to say that the present half-volume is similar to those which have preceded it, and that the high character of the series is fully maintained.

How we Travel. A Geographical Reader. By J. F. Chamberlain. Pp. ix+227. (New York: The Macmillan Co., 1908.) Price 2*s*. 6*d*.

THE intention of the author of the series of four reading books, of which this is the last, is to develop an interest in the subject on the part of young pupils beginning the study of geography. The little book should be popular in the lower classes of secondary schools; it provides a simple, entertaining, and attractively illustrated account of means of travel and communication in various parts of the world. Previous volumes have dealt with man's activities connected with securing food, clothing, and shelter.

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.*]

Solar Vortices and Magnetic Fields.

SEVERAL weeks ago I discussed with Prof. Hale the matter of solar vortices and magnetic fields, with reference to his recent discoveries, briefly described in NATURE for August 20 (p. 368). It did not seem to me probable that the effects could be accounted for by unequal diffusivity of the positive and negative ions, or by centrifugal separation, nor does it seem necessary to assume, with Prof. Zeeman, that the magnetic effects are due to electrons participating in the vortical motion. Since that time I have recalled that, so far as definite evidence goes, *all luminous vapours giving a line spectrum, and therefore capable of showing the Zeeman effect, are positively charged.* A flame coloured with sodium or lithium vapour and placed between two condenser plates is attracted by the negative plate. This fact was used by Lenard to determine the velocity of the positive ions. As shown by Riecke and Stark (*Phys. Zeit.*, v., 537, 1904), if a sodium or lithium salt is placed on the kathode of a long spark the coloured vapour remains in that neighbourhood; if placed on the anode it is at once projected across the entire length of the gap. Hemsalech (*Comptes rendus*, cxlii., 2, 1906) proved spectroscopically that the metallic vapour in the spark is projected solely from the positive electrode. As shown by Stark (*Ann. der Phys.*, xiv., 529, 1904), that part of the luminous vapour in a mercury arc which gives a band spectrum is unaffected by an electric field, while that part which gives a line spectrum is positively charged. The canal and anode rays are likewise examples of positively charged carriers giving a line spectrum.

What becomes of the negative electricity in these cases is obscure; but the fact remains that somehow, either in the form of projected electrons or more rapidly moving negative ions, it gets away, and leaves behind the positively charged ions of the luminous vapour. If such is the case on the earth, we should expect it to be true of the luminous vapours of hydrogen, calcium, and other elements on the sun. Whether the vapours taking part in the sun-spot vortices are positively charged can easily be determined from Prof. Hale's observations on the Zeeman effect.

It would be interesting to know whether the solar vortices follow a definite cyclonic law, as is the case in the earth's atmosphere. If so, a definite resultant polarity should be produced by the aggregate of sun-spots, and accompanying magnetic fluctuations on the earth should be always in one direction. If the vortices are accidental the terrestrial effects should be irregular.

This line of thought raises questions as to the effect of the enormous mass of positive luminous vapours participating in the solar rotation. Will it give rise to magnetic effects? Perhaps not if ether is dragged with the sun; at any rate, a charged body rotating with the earth seems to produce no magnetic field. If, however, there are solar atmospheric currents on a large scale magnetic effects may be expected. If the sun is thus magnetised it would act inductively on the earth, and the magnetism of the earth might be thus accounted for. The sun's north pole should be positive to account for the negative polarity of the earth's geographic pole, and it is interesting to note that such would be the case if the sun's polarity is due to positively charged vapour rotating with it.

It would likewise follow that the moon is an induced magnet. It might be worth while for someone to consider the effects upon perturbations of earth and moon of the force moments due to the non-coincidence of the polar and magnetic axes.

If the supposed positive charges in the chromosphere arise from the projection of electrons into space, the accumulation of the latter in outer regions would produce with the positive atmosphere an enormous electrical double layer, with a radial field which would restrain further travel of the electrons and perhaps cause the tremendous outbursts of luminous positively charged vapour shown in prominences. Magnetic effects in these prominences should be looked for.

Very light ions (perhaps of some lighter element than any we know) might be drawn from the sun by the electric field, and their subsequent neutralisation by electrons may give rise to coronal line radiation. These encounters, always taking place in radial lines, may give rise to partially polarised radiation, but it must be confessed that it seems difficult to reconcile the effects which would probably follow with the observed direction of vibration in coronal light. E. PERCIVAL LEWIS.

University of California, September 14.

Memory in the Germ-plasm.

IT has recently been suggested that acquired characters are transmitted by a kind of memory in the germ-plasm. If this suggestion were adopted, would it not enable us to explain the non-transmission of mutilations?

If there be such a connection between the somatic-cells and the germ-cells as this new theory presupposes, that connection must be constant. We must suppose the germ-cells to be a kind of registry in which all the events of the somatic life are recorded. Many of the records would be evanescent, just as many of the records in consciousness are evanescent, but important somatic changes would (by the accumulation of impressions) produce perduring records, and these would be the biological ground of the transmission of those changes to the new generation.

Now consider what happens in mutilation. A lamb's tail is shortened—what is the result in germ-memory? Merely the record of a momentary cut. Why should this be transmitted? There is already in the germ-memory the record of an undiminished tail—a record produced by thousands of impressions accumulated through every moment of the animal's earlier life. Naturally, this record will be prepotent over the record of a momentary event.

We must remember, too, that the nerves and muscles of a stump often strangely preserve for a long time what may almost be called a recollection of the amputated part. If the lost limb thus perpetuate itself (so to speak) in consciousness, it seems probable, *ex hypothesi*, that it similarly perpetuates itself in germ-memory. Moreover, a man who has lost a leg constantly tries (consciously or subconsciously) to act as though he still had it. This, again, one may suppose, would tend to perpetuate the germ-record of the lost member.

It seems, then, that, in a case of mutilation, the record in germ-memory of the momentary act of mutilation would be an evanescent record, and the germ-record, as a whole, would continue to be the record of an unmutilated body. Does not this help us to understand the non-transmission of mutilations? HAKLUYT EGERTON.

Models of Plane and Spherical Waves.

IT is very easy to form a mental picture of the displacements in an isotropic elastic solid transmitting a plane transverse wave. Alternate planes of constant phase are sheared relatively to one another, as explained in Schuster's "Optics," § 12. If this be a correct representation of the process of transmission, it should be possible to apply a similar method to the alternate spherical shells in the transmission of a spherical wave. The shears must obviously possess symmetry about the point centre of the disturbance, since the waves are transmitted uniformly in every direction. This appears to me to be impossible; but if such shears are impossible in a spherical wave it is absurd to apply them to a particular case of the spherical wave, viz. a plane wave. Will some kind friend please explain? J. J. D.

THE following explanation may be helpful if I understand the difficulty aright.

Imagine a number of concentric spherical shells like the layers of an onion. Imagine the inside shell rotated about a diameter through a small angle, and imagine this displacement taken up in succession by the next shell, the next but one, and so on. Then we have a disturbance radiating outwards from the centre, but the wave motion is *not* symmetrical about the centre. If, however, we go to a long distance from the inside sphere along a perpendicular diameter we get *practically* plane waves.

But these plane waves are in no way the limiting case of spherical waves *symmetrical about a point*, for the vibrations take place in a particular direction (in other words, they are plane polarised). It is impossible to have shears in *plane* waves which possess the symmetry referred to by your correspondent. A pack of cards can be sheared parallel to its longer or shorter side or to its diagonal, but it cannot be sheared at the same time equally in all directions. There is no difference between plane and spherical waves in this respect. Light spreading out uniformly from a source is a very different thing from these simple plane and spherical waves. It represents a jumble of waves sent out from a large number of molecules, and these molecules are not only moving about and changing their positions, but are themselves rotating. The radiations they emit are probably different from the motions of the spherical shells described above, but these do by way of illustration. G. H. B.

The Pendulation Theory.

IN NATURE of April 2, 1908, the reviewer of my "Pendulationstheorie," Mr. R. L., directed attention to the map which shows the distribution of the ichthyosaurs, because I have left out the African ones. He therefore thinks it difficult to commit himself to an opinion on the theory.

Those ichthyosaurs in Africa (not yet marked in the edition of Zittel's "Palæontology" I have used) are not in the least an argument against my theory, but give me another most striking proof of it. I had shown that the ichthyosaurs had taken their origin under the pendulation circle, and had wandered from there on the usual line south-eastward to New Zealand. For they have been found under the pendulation circle from Spitsbergen to Sicily, all the others on a line from Europe to New Zealand.

Their having been found in Africa only enlarges their extension along the pendulation circle, and so confirms my opinion that the ichthyosaurs have here taken their origin.

Another instance, quite recently discovered, offers the fluviatile medusa Limnocodium. Until recently it was only known in aquariums; it was first found in England, and described by Lankester. Its occurrence together with *Victoria regia* proves that its origin is in the tropical parts of America. Some time ago Prof. Oka described a second species from the upper Yang-tse-kiang. That is just the same discontinuous occurrence which I have pointed out, for instance, for the alligators, and which I have made use of for the pendulation theory. H. SIMROTH.

Leipzig, Gautzsch, August 21.

SURVEYING FOR ARCHÆOLOGISTS.[1]

V.

Why the Measurement of Altitude is Necessary.

It is now time to enter more into detail on a point to which reference has already been made, as it is one of great importance to all British archæologists, as Britain lies in a mid-latitude. If a star or the sun did not rise or set every day in Britain as happens at the poles, or rose and set vertically, as happens at the equator, the height of the horizon would not come into play.

As a matter of fact, however, in Britain some celestial bodies do rise and set, and *not* vertically; their paths, as we have seen, are inclined to the horizon, and therefore the azimuth of the rising or setting place depends upon the height of the horizon, and I may add that the zenith distance must be less than 90° if the horizon is raised by hills.

In order to consider this matter more closely, I give in the accompanying figures the actual facts of the sunrise on the N.E. horizon at the longest day of the year in two British latitudes, Stenness, lat. 59° N., and Cornwall, lat. 50°. They will illustrate the effect of latitude upon azimuth as well as the change of azimuth in presence of hills which now specially concerns us.

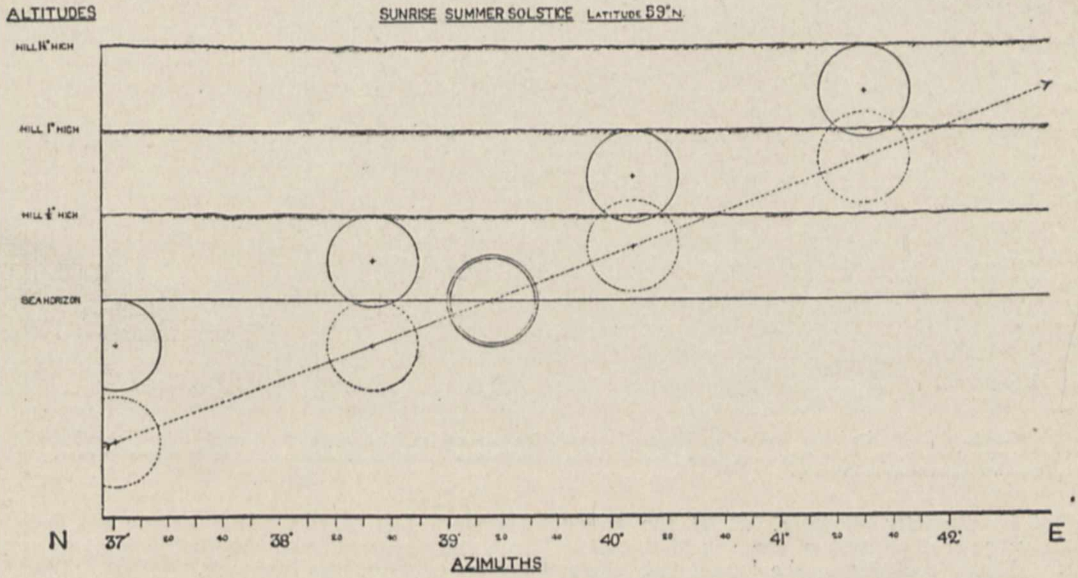


Fig. 19.—The conditions of "sunrise" at the summer solstice in lat. 59° N.

But before we consider them, I must refer to another matter.

The light from sun or star when it enters the earth's atmosphere is refracted or bent out of its course, and the more slantingly it enters the atmosphere, as happens near rising and setting, the greater the refraction. In consequence of this the sun or a star appears higher in the heavens than it really is, and therefore appears to rise earlier and set later.

In Fig. 19 we see, diagrammatically, the effect of hills and refraction on the azimuth of the summer solstice sunrise in lat. 59° N. The long dotted line shows the slanting direction of the sun's path in relation to the horizon. The double circle indicates the position of the sun's *centre,* at the sea horizon and neglecting refraction. The azimuth, as shown by the scale at the bottom of the diagram, is N. 39° 16′ E.

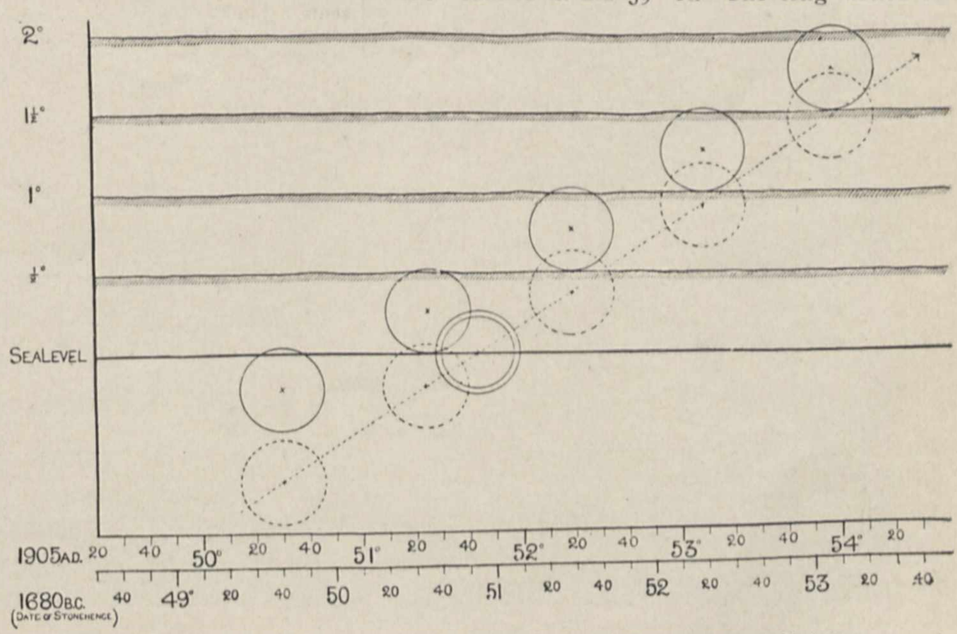
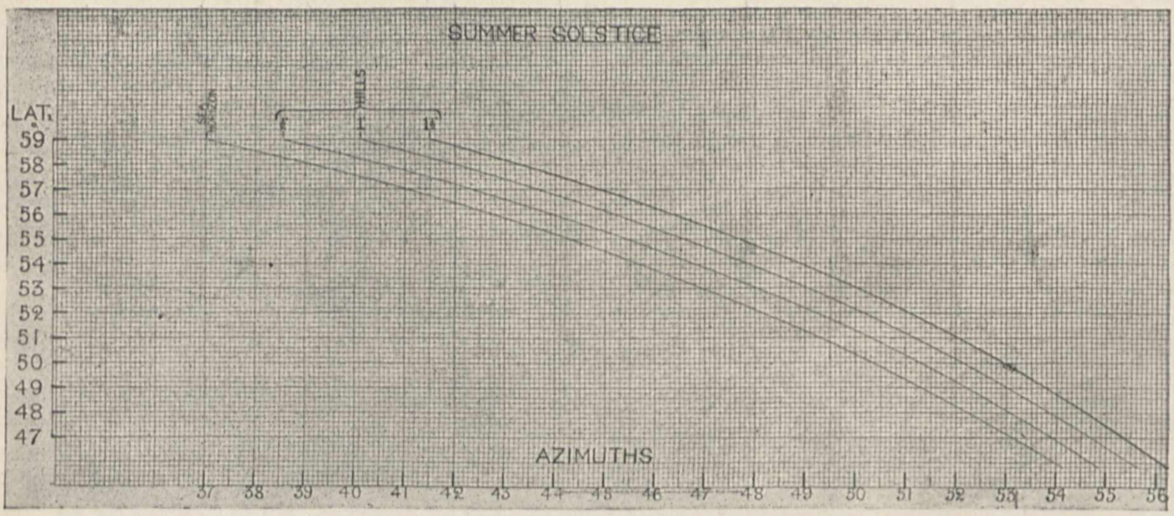


Fig. 20.—Showing azimuths in lat. N. 50° for the summer solstice sunrise, with different heights of hills for 1905 A.D. and 1680 B.C. (From "Stonehenge," p. 290.)

[1] Continued from p. 544.

The full circles show the *apparent* positions of the sun due to refraction, at different horizons, if we apply the refraction correction and consider the sun visible



G. 21.—The Azimuths of the Sunrise (upper limb) at the Summer Solstice. The values given in the table have been plotted, and the effect of the height of hills on the azimuth is shown. The range of latitude given enables the diagram to be used in connection with the solstitial alignments at Carnac, Le Ménac, and other monuments in Brittany.

with 2′ of its diameter showing, whilst the dotted circles show the *real* position of the sun at the same moment. Thus, considering the lowest full circle,

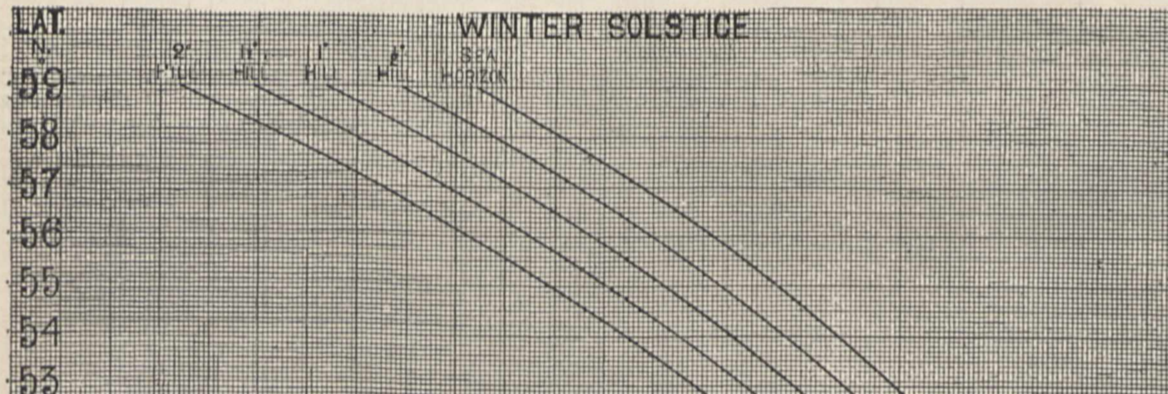


FIG. 22.—Azimuth of Sunrise (upper limb) at Winter Solstice.

in Fig. 19 we see that the azimuth of apparent sunrise, with a sea-horizon, is N. 37° 1′ E.

A comparison of the full-line circles with the lower dotted circles in the diagram will give an idea of the degree of apparent change of place brought about in this way; and how the difference between the true and apparent places rapidly diminishes as the true horizon is left behind. Thus at the sea horizon the true and apparent suns are just separated; with the horizon 1° high they interlock.

The next diagram gives the conditions for lat. 50°. In this latitude, while the sun appears to rise at the present time over the true sea horizon at azimuth N. 50½° E., instead of N. 37° E., as at Stenness, with a hill 2° high the azimuth is very nearly N. 54° E.

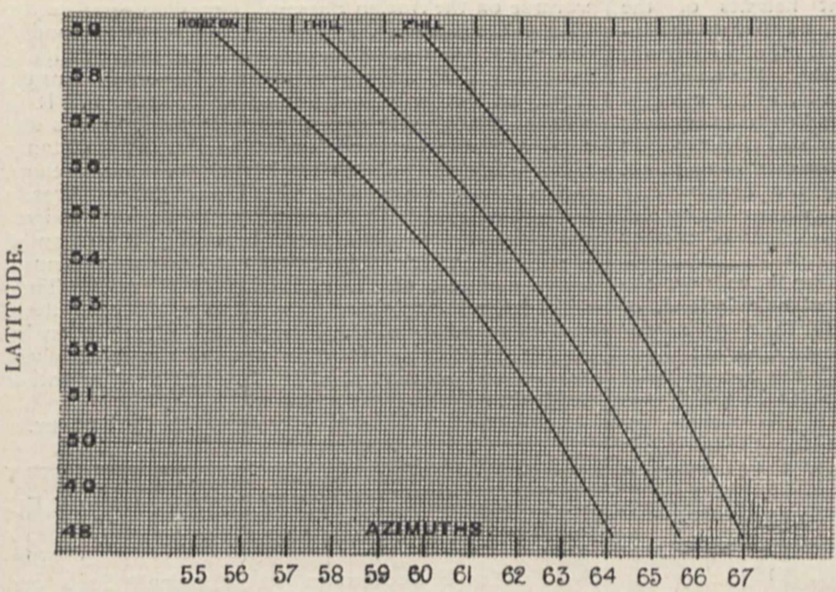


FIG. 23.—Azimuths of the May Sunrise. Sun's declination 16° 20′ N.

The above diagrams show very plainly the great variation in azimuth the archæologist has to reckon with when he roams Britain to determine the orientation of his monuments, whether outstanding stone, recumbent stone, avenue or cromlech. What happens with the solstitial sun also happens with the May and November suns, and warning- and clock-stars. Thus we find, in the case of the summer solstice sunrise, it is seen, with a sea horizon, in az. N. 37° E. at Stenness and N. 50° 30′ E. in Cornwall. A hill $1\frac{1}{2}$° high in lat. 59° changes 37° to $41\frac{1}{2}$°; a hill 2° high in lat. 50° changes $50\frac{1}{2}$° into 54°.

Having now indicated the importance of the measurement of altitude as well as of azimuth, I give diagrams showing the azimuths of the sunrises at the solstices and in May and November, the changes in azimuth caused by varying heights of the horizon being also indicated.

These diagrams are good for the whole of Britain and for part of Brittany. They have been computed by Mr. Rolston, of the Solar Physics Observatory.

There is a relation between the height of the horizon and the refraction correction which may be found useful. If the horizon is half a degree high, the refraction is practically compensated, as the following table will show:—

Elevation of actual horizon	Bessel's refraction	Combined effect
° ′ ″	′ ″	′ ″
0 0 0	... 34 54	... −34 54
0 10	... 32 49	... −22 49
20	... 30 52	... −10 52
30	... 29 3·5	... + 0 56·5
40	... 27 22·7	... +12 37·3
50	... 25 49·8	... +24 10·2
1 0	... 24 24·6	... +35 35·4

In the absence of measurements, it is convenient, therefore, to assume, in the first instance, that the height of the horizon is half a degree; then no refraction correction need be applied.

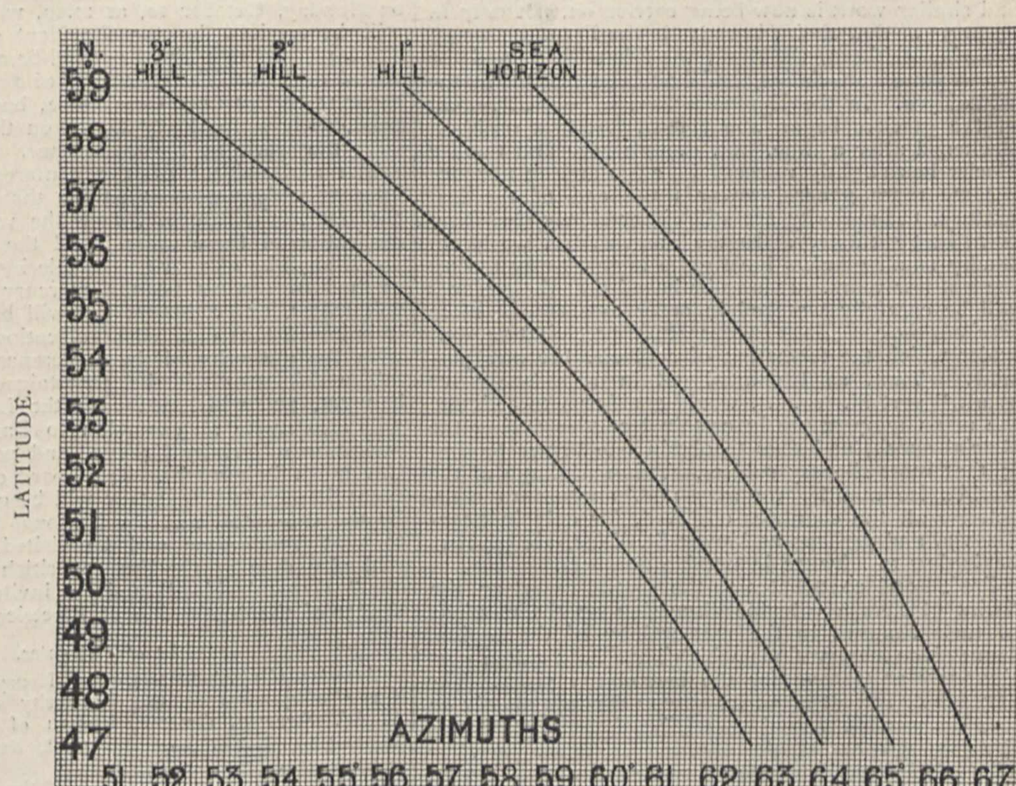


FIG. 24.—Azimuths of the November Sunrise Sun's declination 16° 20′ S.

This relation is utilised in the preparation of general tables and curves, as it provides us with a convenient approximation to the actual azimuths before the height of the horizon has been measured.

Now, while the summer solstice sun thus rises in different azimuths with different heights of the horizon, its position in the heavens, that is, its declination, is unchanged. It is clear, then, that we cannot, by our azimuth measures alone, obtain the true position of the sun in the heavens, that is, in the celestial sphere. The same remark also applies to every star which rises and sets in the latitude of Britain. In addition to the azimuth of the rising or setting place, *we must also take the height of the horizon into account.* When we do this, the determination of the true position in the heavens, whether of sun or star—the declination—is easy.

As I shall show in the sequel, we have now the means, as the result of astronomical calculations, of determining the dates at which the sun or a star occupied declinations in times past different from those they occupy at present. All the archæologist has to do is to consult certain tables in which the sun's declination at the solstice and the varying declinations of the stars are shown for the past six thousand years. This is enough for the purpose the archæologist has in view.

NORMAN LOCKYER.

THE GROWTH AND SHRINKING OF GLACIERS.[1]

THE interesting publications referred to below show that the study of the fluctuations of glaciers is making good progress. Those of the Swiss Alps have been watched systematically for nearly thirty years, and similar work is now being carried on, not only in all parts of that chain, but also in the Pyrenees, Scandinavia, Bokhara, the Altai, the Tian Shan, and the North American chains, and has been started in the Himalayas. In the European Alps a general retreat of the glaciers began about 1861. At first rapid, it slackened after a time, but, though here and there a glacier has slightly retraced its steps and an advance became more general towards the end of the last century, the majority are still either slowly shrinking or at best stationary. In the French Alps, we learn, sundry small glaciers have quite melted away during the last few years. It is to be hoped that these places will be carefully watched in order to ascertain more precisely the conditions (temperature, precipitation, &c.) under which the formation of a glacier becomes possible. That, as I pointed out in 1894 (see "Ice Work," part iii., ch. i.), would enable us to estimate the mean temperature in certain localities during the Glacial epoch, and thus to obtain one firmer footing in that most slippery subject. This shrinkage of the world's ice mantle, we may add, appears to characterise all the countries observed, for only in Scandinavia, and perhaps at Mount St. Elias, are glaciers beginning to advance in notable numbers.

Prof. Forel contributes to the special report on the Swiss glaciers a valuable discussion on the relations of their changes to the meteorology of the region, founded on observations which have been taken continuously at Geneva for the last eighty years. The advance or retreat of an ice-stream depends mainly on two factors: the annual snowfall and the general temperature, the one chiefly affecting its upper part, the other its lower. The effects, especially of the former, obviously cannot be immediate, and a glacier may continue its advance when the conditions are adverse, or *vice versâ*. As forty-three years elapsed before the relics of members of Dr. Hamel's party, who perished in a crevasse on the Ancien Passage, were discovered on the Glacier des Bossons, after travelling about five and a half miles, we must expect changes and their results to be separated by an interval, depending on the length, slope, and other characters of an ice-stream. It is perhaps too soon to generalise from Prof. Forel's discussion of the Geneva observations, and the distance of that observatory from the higher parts of the chain will always be a drawback; but the results are already suggestive, and his method of smoothing off the irregularities of individual years, by taking the mean of the decade which they close, enables us to form a better estimate of the real climatal changes. Time will render the work of the professor, his coadjutors, and all members of the International Commission increasingly valuable; for this is one of the cases where one generation must plant the tree and another gather the fruit.

T. G. BONNEY.

[1] "Les Variations périodiques des Glaciers." xii^{me} Rapport, 1906, de la Commission internationale des Glaciers. Résumé par F. A. Forel. *Arch. des Sci. Phys. et Nat. Quatr. Pér.*, t. xxv., pp. 577–587.

"Les Variations périodiques des Glaciers des Alpes Suisses." By F. A. Forel, E. Muret, P. L. Mercanton and E. Argand. 28^{me} Rapport, 1907. Extrait de l'Annuaire du S.A.C., xliii^{me} année. Pp. 302–331.

INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS.

BY invitation of the British Government an International Conference on Electrical Units and Standards will be held in London at the rooms of the Royal Society during this month. Eighteen countries are sending delegates to the conference; the names are given below.

The first meeting of the conference will be held on Monday, October 12, at 11.30, when the delegates will be received by the President of the Board of Trade; in the evening there will be a reception by the Royal Society. The meetings of the conference are expected to last until October 22, but this date is not fixed, as it will entirely depend on the progress made with the work at the conference.

The main object of the conference is to obtain international agreement on the three electrical units, the ohm, the ampere, and the volt, so that the realisation of these units in all the countries of the world shall be as near as possible identical. The best method of setting up the mercury ohm, the silver voltameter, and cadmium cell will be considered, and it is hoped that detailed specifications may be issued with the authority of the conference.

The delegates will be entertained at an official banquet, and will lunch with the Lord Mayor; they will also make an excursion to Cambridge on the invitation of Trinity College, and pay a visit to the Cavendish Laboratory. The Board of Trade Government Standards Laboratory will be open to inspection by the delegates, and the National Physical Laboratory at Teddington will be visited. The delegates will also dine at the Franco-British Exhibition with the "Dynamicables," and are invited to the annual dinner of the Institution of Electrical Engineers.

List of Delegates.

America (United States).—Dr. Henry S. Carhart, professor of physics at the University of Michigan; Dr. S. W. Stratton, director, Bureau of Standards, Washington; Dr. E. B. Rosa, physicist, Bureau of Standards, Washington.

Belgium.—M. Gérard, director of the Montefiore Electrotechnical Institution and president of the Consultative Commission on Electricity; M. Clément, secretary of the Consultative Commission on Electricity.

Denmark and Sweden.—Prof. S. A. Arrhenius, Nobel Institute, Stockholm.

Ecuador.—Senor Don Celso Nevares, Consul-General.

France.—M. Lippmann, member of the Institute and professor at the Sorbonne.

Germany.—Dr. Warburg, president of the Imperial Physico-technical Institute; Dr. Jaeger, member of the Imperial Physico-technical Institute; Dr. Lindeck, member of the Imperial Physico-technical Institute.

Great Britain.—The Right Hon. Lord Rayleigh, president of the Royal Society; Prof. J. J. Thomson, Cambridge; Sir John Gavey, C.B.; Dr. R. T. Glazebrook, director of the National Physical Laboratory; Major W. A. J. O'Meara, C.M.G., Engineer-in-Chief, General Post Office; Mr. A. P. Trotter, Electrical Adviser to the Board of Trade.

Guatemala.—Dr. Francisco de Arce, diplomatic representative, London and Paris.

Italy.—Prof. Antonio Roiti, of Florence.

Japan.—Mr. Osuke Asano, doctor of engineering, official expert of the Department of Communication, Tokyo; Mr. Shigeru Kondo, official expert of the Department of Communication, Tokyo.

Mexico.—Don Alfonso Castello; Don Jose Maria Perez.

Netherlands.—Dr. H. Haga, professor at the University of Groningen.

Paraguay.—M. Maximo Croskey.

Spain.—Don Jose Maria Madariaga, professor of electricity and physics at the School of Mines, Madrid.

Switzerland.—Dr. F. Weber, professor at the Swiss Polytechnic School at Zürich; Dr. Pierre Chappuis, of Bale; Dr. J. Laudry, professor of electricity in the School of Engineers, Lausanne.

British Colonies: Australia.—Mr. Cecil Darley; Prof. Threlfall.

Canada.—Mr. Ormond Higman, chief electrical engineer, Inland Revenue, Ottawa.

Crown Colonies.—Major P. Cardew, electrical adviser.

India.—Mr. M. G. Simpson, electrician of the Indian Telegraph Department.

MR. BENNETT H. BROUGH.

ALL members of the Iron and Steel Institute, and, in fact, all those engaged either directly or indirectly in the manufacture of steel, were shocked by the sudden and unexpected death of Mr. Bennett Brough, the general secretary of the Iron and Steel Institute at Newcastle-on-Tyne, on Saturday last, after an operation for peritonitis. He had been attending the autumn meeting of the Institute in Middlesbrough, and up to Thursday appeared to be in normal health, and was taking his usual active part in making the meeting a success.

Mr. Brough was born in 1860, and was educated at the City of London School, and after graduating at the Royal School of Mines was for some time a student at the Mining School at Clausthal. Some time after the completion of his student career at Clausthal, he was appointed instructor in mine surveying at the Royal School of Mines, and only resigned on his appointment as secretary to the Iron and Steel Institute in 1893.

As early as 1885 he acted as a juror at the Inventions Exhibition, was a member of the Mining and Metallurgical Committees of the British Section of the Paris Exhibition of 1889, and of the St. Louis Exhibition of 1904, and the success of the Iron and Steel Section at the Franco-British Exhibition is in no small degree due to his great organising ability and untiring efforts.

Mr. Brough was not only a sound technical man, but a brilliant linguist, and a man of very wide culture and extensive travel. His well-known book on mine surveying and numerous contributions to the various technical and learned societies are known all over the world, and he was an accepted authority on mining matters.

He acted as examiner in mining at the Royal School of Mines, the Glasgow University, and the University of Wales, and he was a member of the council of the Institution of Mining Engineers; he served on the council of the Institute of Chemistry and the Chemical Society, and was also a Knight of the Swedish Order of Wasa.

As general secretary of the Iron and Steel Institute there were few men more widely known in the metallurgical world, and none more universally esteemed and respected. He was equally accessible to the youngest as to the oldest member of the institute, extending the same courtesy and consideration to all. He was a man of few words, but many kindly deeds, and not only those who were privileged to number him amongst their friends, but all who knew him, have suffered an irreparable loss.

NOTES.

A SPELL of exceptionally brilliant and hot weather for so late in the year occurred over the whole of the British Islands during the last three days of September and the first four days of October, and in nearly all parts of the country previous records fail to show any shade temperatures as high for the corresponding period. At Greenwich the maximum readings exceeded 70° each day, and on the six days from September 29 to October 4 it was 75° or above, the absolutely highest temperature being 79°·9, on September 30. An examination of the Greenwich records from 1841 shows a temperature of 79°·2, on October 4, 1886, but there is no other reading higher than 78° so late in the season. At Nottingham 78° occurred on October 3, whilst the previous highest temperature during the month in the last thirty-five years is 75°, in 1895. At Bath 77° was registered on October 1 and 2, and the highest previous record for the month is 73°, in 1873. At Shields the reading was 77° on October 3, and the previous highest reading in October is 69°, in 1898. All previous records were also broken by 77° at Aberdeen, 76° at Jersey, Nairn, and Valencia, 75° at Holyhead, and 73° at Leith, between October 1 and 4. A feature of especial interest during the hot spell was the exceptionally warm nights, the thermometer commonly not falling below 60°. The Weekly Weather Summary for the period ending October 3, issued by the Meteorological Office, shows that the mean temperature was more than 11° in excess of the average in the north-east and north-west of England and in the Midland counties, whilst the sheltered thermometer registered 80° in all these districts. Much fog or mist occurred at night, and the air throughout the hot spell was exceedingly humid, the ground remaining damp all day where screened from the sun's rays. The primary cause of the hot weather was a quiet drift of southerly air from off the heated land in Spain and France, due to the prevalence of a region of high barometer readings over Germany. At Rochefort and Biarritz the sheltered thermometer registered 86° on October 2.

WE learn from the observatory department of the National Physical Laboratory that highly disturbed magnetic conditions prevailed there on September 29–30. A magnetic storm commenced suddenly about 1.32 a.m. on September 29. After 7.30 a.m. the curves were only slightly disturbed during a period of fully six hours, when fresh disturbance appeared. Considering the length of the interval, it was probably a case of two distinct magnetic storms. On this view, the first storm lasted about six hours, during which time the declination showed a range of 54′, while the ranges of horizontal force and vertical force were respectively about 225 γ and 160 γ (1 γ = 0·00001 C.G.S.). The second storm, commencing suddenly about 1.45 p.m. on September 29, continued until 7 a.m. or

8 a.m. on September 30. During it the declination range was about 73′, while the ranges in horizontal and vertical force were each approximately 330 γ. On September 29 there was a remarkably fine oscillation in declination commencing at 6 p.m. In the course of eleven minutes the magnet swung 39′ to the west, with a return movement of 46′ to the east. In the course of this day, both in the morning and afternoon, there were a number of smaller but very rapid oscillations of the type usually associated with aurora. It is thus of interest to note that the Daily Weather Report of September 30 announces aurora as having been observed in various parts of Britain on the previous day, whilst the newspapers report the occurrence of unusually vivid aurora in the United States. It will be remembered that a large magnetic storm was recorded at Kew on September 11–12; it is unusual for disturbances so large as those of September 12 and 30 to occur in such rapid succession.

The Harveian oration of the Royal College of Physicians of London will be delivered by Dr. J. A. Ormerod on Monday, October 19, at 4 p.m.

The Italian Society of Sciences (Accademia dei XL) has awarded its biennial mathematical prize to M. Giuseppe Picciati, of the University of Padua, for his series of mathematical works.

Prof. E. C. Pickering, of Harvard University, has been elected president for the ensuing year of the Astronomical and Astrophysical Society of America, and Prof. W. J. Hussey, of the University of Michigan, the secretary of the society.

On October 6, at Le Mans, Mr. Wilbur Wright accomplished a flight of 1h. 4m. 26s. in duration, carrying a passenger. The nearest approach to this flight with a passenger was Mr. Wright's record of thirty-five miles in 55m. 35·6s. on October 3.

A conference of members of the Museums' Association and others interested will be held at Rochdale on Thursday, November 5, for the purpose of discussing subjects of interest to those concerned in the work of museums, art galleries, and kindred institutions.

The death of M. Alphonse Boistel, at the age of seventy-one years, is announced. M. Boistel was known as the author of a "Nouvelle Flore des Lichens," and as treasurer, and subsequently president, of the Geological Society of France. Science was a leisure-hour pursuit with M. Boistel, who for forty years was professor of commercial law in the University of Paris.

At the meeting of the German Meteorological Society in Hamburg, to celebrate its twenty-fifth anniversary, the following were elected honorary members:—Dr. W. N. Shaw, F.R.S., director of the Meteorological Office, London; M. A. Angot, director of the Bureau Central Météorologique, Paris; M. L. Teisserenc de Bort, director of the Observatoire de Météorologie dynamique, Trappes (France); and Prof. A. L. Rotch, director of Blue Hill Meteorological Observatory, U.S.A.

On Saturday, October 10, the Essex Field Club will hold a conference and demonstration at the Franco-British Exhibition. The main object of the meeting will be to demonstrate the value of some of the exhibits as illustrations of the methods which may be employed in promoting and encouraging nature-study in schools, and to discuss the best mode of utilising local museums as centres and standards of reference in such instruction. All interested in these subjects are invited to attend. Applications for programmes and other information should be made to the hon. secretary, Mr. W. Cole, Buckhurst Hill, Essex.

The death is announced, in his sixty-ninth year, of Dr. Francis Huntington Snow, who took a prominent part in scientific teaching in the University of Kansas from its establishment in 1866. He was Chancellor of that University from 1890 to 1901, and after his retirement from that post continued to hold the chair of systematic entomology. In recognition of his services the Kansas Legislature built several years ago the Snow Hall, to hold his valuable collection of 22,000 insects, made during twenty-six expeditions in Kansas, Colorado, New Mexico, Texas, and Arizona. American farmers owe much to his experiments in the artificial application of fungus diseases to the destruction of chinch bugs, especially in the wheat fields.

The latest development of the policy of the Forest Service at Washington is the projected establishment in the west of a number of forest experiment stations, which, it is anticipated, will do for American forestry what the agricultural experiment stations have done for the country's farms. The first station of the series has been established in the Coconino national forest, with headquarters at Flagstaff, Arizona. Here special attention will be paid to a study of the reproduction of the western yellow pine and the causes of its success and failure. One of the most important functions of these stations will be the maintenance of model forests, typical of the region, as object-lessons for professional foresters, lumbermen, &c.

Writing to the *Times* of October 1, Mr. R. Burnard, hon. secretary, Dartmoor Preservation Association, states that the most serious destruction of antiquities, and one for which, apparently, there can be no excuse, has just been reported to him. It appears that the War Office recently acquired a large tract of country at Willsworthy, near Lydford, for training purposes, and on this stands White Hill, an eminence of nearly 1300 feet, recently crowned by thirteen tumuli; these have been swept away, in order, so it appears, that a flagstaff may be set up. Mr. Burnard adds:—"The ignorance of a country road-mender helping himself to what is handiest in the way of stone may be excused, but this last destruction is at present inexplicable, for assurances were given when the property was acquired that all the antiquities would be respected as far as the exigencies of the service would permit."

A brilliant assembly, organised by the committee for the erection of a monument to the late Prof. Marcelin Berthelot, the founder of synthetic chemistry and of thermochemistry, met at the Sorbonne on Sunday night. M. Fallières, President of the French Republic, was present, and also M. Clemenceau, the Prime Minister, and M. Doumergue, Minister of Education. We learn from the Times that in an eulogy upon the great *savant* M. Raymond Poincaré said:—"After his death there was found on his table, indicative of his last thoughts, a memoir on the alkaline compounds in vegetables, an old Arab manuscript on alchemy, which he had only just managed to obtain from the Mosque of Fez, and an address to the French of the Argentine Republic. He had thus, for the last time, united in his final preoccupations truth and the fatherland." M. Fallières also spoke eloquently of Berthelot, who, he remarked, remained to the last one of the noblest apostles of science, of independent thought, of justice, and of truth.

DR. AND MRS. BULLOCK WORKMAN, accompanied by Dr. C. Calciati and Dr. M. Koncza, surveyors, have carried out successfully a detailed survey of the Hispar glacier in Hunza-Nagar. We learn from the *Pioneer Mail* that, after remaining five weeks on the Hispar, camping much of the time on snow, at altitudes of from 16,000 feet to 19,500 feet, Dr. and Mrs. Bullock Workman, with guides and a caravan of Nagar coolies, crossed the Hispar pass and descended the Biafo glacier—thirty miles long—reaching Askole, Baltistan, on August 26. Although the chief objects of the expedition were glacial study and mapping, several new peaks and snow passes were climbed, the most notable being a very steep and difficult snow peak of about 22,000 feet, situated some distance to the north of the Hispar pass, on the watershed of the Hispar and Biafo glaciers, overlooking the solitudes of Snow Lake at the head of the Biafo glacier. This is the second traverse by Europeans of these two glaciers, the first having been made by Sir Martin Conway in 1892.

MR. J. T. CART, whose death we announce with regret, entered the School of the Pharmaceutical Society in October, 1902, as Bell scholar, was appointed demonstrator in chemistry in October, 1903, and demonstrator in pharmaceutics in April, 1904, a post which he held until he took up an appointment with the firm of Messrs. Hopkin and Williams in July, 1905. There he gained additional experience in analytical and manufacturing chemistry under the supervision of Mr. Edmund White, leaving in 1906 for Newcastle-on-Tyne, where he was appointed chemist to Messrs. C. A. Parsons and Co. to carry on chemical engineering research work, and to deal with such chemical questions as arise in the carrying on of engineering and electrical business generally. His work while at Newcastle threw him much into contact with Mr. Charles A. Parsons and others, who held him in the highest regard. To all who had the privilege of his acquaintance and friendship, his sudden and untimely death has come as a great shock and sorrow. Mr. Cart was a B.Sc. of London University, an Associate of the Institute of Chemistry, and a member of the Northern Scientific Club.

VOL. xiii. (pp. 547–752) of the Transactions of the South African Philosophical Society is devoted to the concluding portion of the descriptive catalogue of the Coleoptera of South Africa, and deals mainly with the family Scarabæidæ, of which a large number of new species is described. It is illustrated with one plate.

ABOUT thirty years ago a remarkable collection of fossil plants and insects was discovered in beds of shale of the Miocene period at and near Florissant, a small town in Colorado. The plants were described by Lesquereux, and Dr. Scudder published an important monograph on Tertiary insects. Interest in these remains has again been aroused by recent workings, upon which subject Prof. T. D. A. Cockerell contributes an article to the *Popular Science Monthly* (August). The flora included many trees similar to those existing in other parts at the present day, such as Liquidambar, redwoods, and cottonwoods, also an abundance of ferns. Two unique specimens were discovered in the shape of a fungus that has been named *Didymosphaeria betheli*, and a tuft of moss bearing capsules. Some remarkable insects were also unearthed, notably a Glossina, or tsetse-fly, a genus now confined to Africa, also a genus, Halter, known only at the present day in Chile, and two butterflies.

IN their report for 1907–8, the authorities of the Manchester Museum announce the acquisition of a tomb-group of the twelfth dynasty, discovered by Prof. Flinders Petrie at Rifeh, Upper Egypt, and consisting of two painted sarcophagi, with body-coffins and mummies, two boats with sailors, a finely painted canopic chest, of which all the contents are complete, and five statuettes, all being of the best workmanship. Reproductions from photographs of the statuettes and boats accompany the report, which also contains an illustration of a family group of striped hyænas recently added to the exhibition-series.

THE School Nature Study Union has issued a series of leaflets intended for teachers or for use in class. The early numbers are introductory, indicating the facilities offered by museums and gardens—we should have expected the reverse order—in and near London, suggesting schemes for study, and giving a list of useful books. Subsequent publications deal with seeds, bulbs, sun-dials, tree twigs, rocks, insects, and the school aquarium. The note on sun-dials and how to make one, by Miss N. Sweeny, is certain to be useful, and Miss S. E. Isaacson has collated the chief characters of the more prominent insects. Miss K. M. Hall has provided a practical article on the culture of bulbs. The leaflets can be obtained from the secretary of the union, 1 Grosvenor Park, Camberwell.

THE first part of the eighth volume of the *Museums Journal* contains the annual report of the Museums Association. This is in every way satisfactory, the membership showing some increase, while the sale of the journal has also expanded. The presidential address, by Dr. Jonathan Hutchinson, was devoted to the *rôle* of museums from an educational point of view. In this respect simplicity was strongly insisted upon as one of the most necessary factors, while the president likewise dwelt upon the importance of a "space-for-time-method" for exhibition purposes. In the museum at Haslemere, for example, the building devoted to geology is divided into a number of equal-sized compartments, each supposed to represent a period of one million years, and severally devoted to different geological epochs. The idea certainly seems worthy of further development.

IN a recent number of the *Comptes rendus de la Société de Biologie* (vol. lxiv., p. 1004), Messrs. Chatton and Alilaire describe a new species of trypanosome, very similar in appearance to *Trypanosoma dimorphon*, found by them in the Malpighian tubules of *Drosophila confusa*, Stæger, a small fly common in distilleries and breweries feeding on yeasts. In the intestine of the Drosophila the authors also found a Herpetomonas, which they think may represent a stage of the trypanosome. This is the first time that a true trypanosome has been found anywhere but in the blood of a vertebrate or the digestive tract of a blood-sucking invertebrate, though species of the allied genus, Trypanoplasma, are known to occur in the gut as well as in the blood of fishes. It is greatly to be hoped that the authors will follow up their discovery by working out the life-cycle of the trypanosome and its mode of transmission from one host to another.

THE report of the Alexander McGregor Memorial Museum, Kimberley, for the period ended December 31 last has just been received, from which we note that substantial progress has been made in the fitting up and equipment of the institution; also that Miss Wilman, of the South African Museum, has been appointed curator, and that she will take up her duties by the end of February next. The board trusts, "as all other museums in the colony have received, at the least, pound for pound grants in aid of building and furnishing funds, in addition to annual grants for upkeep, that the Government will, as soon as its funds permit, make a substantial grant in aid of the fitting-up of this museum, as well as an increased grant in aid of upkeep, so as to enable the only museum in northern Cape Colony to be organised and administered in a manner worthy its place as an educational institution."

The dread of premature burial has always been a very real one among some members of the community, so much so that an association for the prevention of premature burial exists. Its physician-in-chief, Mr. Brindley James, has issued a booklet entitled "Death and its Verification" (Messrs. Rebman, Ltd., price 1*s.* net), in which the various tests of death are detailed. They are all simple ones, and some will probably be new to most practitioners.

The study of the topography and municipal history of Praeneste, contributed to series xxvi. of the Johns Hopkins University papers on historical and political science by Mr. R. Magoffin, opens a collection of geographic-historical memoirs on the cities of the Latin League which promises to be of considerable interest. The position of the city, the modern Palestrina, situated on Mount Glicestro, marks it out as the strategical key of Rome, and its political and religious rival. The study of the remains of the cyclopean walls, with their gates open in the direction of the chief water supply, the reservoirs, the remarkable pair of caves, whence, as tradition tells, when the rock was opened pieces of wood inscribed with ancient characters leaped out, afterwards associated with the curious cult of Fortune Primigenia, and the details of the municipal government, based upon a study of the epigraphical materials, is a good example of the new methods of investigation which are now being applied to the solution of the archæological problems of the ancient Italian cities. Mr. Magoffin promises elsewhere to provide a coloured diagram showing the stages of the city's growth. His review of the many problems connected with the site would have been more readily intelligible if the present memoir had been accompanied by a sketch-map.

The Commonwealth Bureau of Meteorology, Melbourne, under the superintendence of Mr. H. A. Hunt, has commenced the publication of bulletins dealing with the meteorology of the whole of Australia. No. 1 (issued March) is an excellent general epitome of the climate and meteorology of that continent, by Mr. G. H. Knibbs, reprinted from the year-book of the Commonwealth, and contains the averages and extreme values at the Australian capitals from a long series of observations, illustrated by diagrams showing the annual fluctuation of the various elements. No. 2 (issued July) deals specially with rainfall, and includes a map showing the mean annual values for the decade ending 1906 (an unusually dry period). The map shows that the heaviest rains fall over the northern and eastern parts of Australia; Mr. Hunt states that the most trustworthy, although lighter rains, are experienced over the south-western and south-eastern portions, including Tasmania. These bulletins may be welcomed as an important addition to meteorological literature.

The annual report of the Royal Alfred Observatory, Mauritius, for 1907 shows that the rainfall for that year, from a mean of sixty-seven stations, was 13 inches below the average. The tracks of four out of eight cyclones which occurred in the Indian Ocean have been plotted. Photographs of the sun were taken daily when the weather permitted, and 300 negatives were sent to the Solar Physics Committee; particulars of fifty-four earthquakes were forwarded to the Seismological Committee of the British Association, and weekly summaries of the weather from May to December were cabled to the director-general of Indian observatories in connection with the monsoon predictions. We regret to learn that the clerical work is falling into arrear, owing to a reduction in the vote for extra assistance, and that from want of funds the observations for 1902 and 1903 are still unprinted. The value of the work of the observatory in connection with international cooperation can hardly be overrated; it is one of the places mentioned in the resolutions of the International Association of Academies at the meeting in May, 1907, and the Meteorological Committee (London), referring to this subject in its last annual report, mentions the observatory as "one of the most important scientific establishments of the southern hemisphere."

We have received from Messrs. Heynes, Matthew and Co., of Cape Town, a catalogue of scientific apparatus stocked by them. The list includes apparatus for collecting and storing botanical, zoological, and mineralogical specimens, also microscopes, reagents, and instruments required in bacteriology. We notice among the contents wire presses for drying plants, Grubler's stains, Hearson's incubators, and geological outfits for prospectors. It will interest readers in South Africa to know that these can be obtained without sending to Europe.

In a note in the Transactions of the American Mathematical Society, ix., 2, Prof. J. L. Coolidge discusses the "equilong" transformations of space. In an "equilong" transformation, if any oriented plane is cut by three non-coaxial oriented planes infinitely near thereto in a triangle, this triangle transforms into a triangle equal in all respects to it. The author finds that the most general "equilong" transformation in a Euclidean space of n dimensions depends on the most general conformal transformation of a space of $n-1$ dimensions, and an arbitrary function of the direction parameters. The distance parameter enters linearly. The mathematical proof which is given for three-dimensional space is easy to follow.

An important essay on logic and the continuum has been contributed to the Bulletin of the American Mathematical Society for June by Prof. E. B. Wilson, of Boston, U.S.A. It deals largely with Zermelo's proposed solution of the problem, first stated by Prof. Georg Cantor in 1883, as to whether every set, and in particular the continuum, can be well ordered. In a postscript the author refers to Schœnflies's report on the same subject. Among Prof. Wilson's conclusions, the view is put forward that the well ordering of any set is of practically no significance, and is quite worthless apart from an algorithm which accomplishes the ordering—an algorithm which shall not require an operation which transcends the cardinal number of the given set. This quotation must be regarded as a mere indication of the general character of the questions discussed in the paper.

The fact that the salient feature of modern practice is the successful handling of low-grade materials from which the value could not profitably be extracted by older methods is strikingly emphasised in an article on modern developments in the metallurgy of lead and zinc, by Mr. A. Selwyn-Brown, in the *Engineering Magazine* (vol. xxxv., No. 6). Descriptions are given of the Huntington and Heberlein process, the Carmichael-Bradford process, the

Savelsberg process, pot roasting, briquetting fine sulphides, the Dwight and Lloyd sintering process, flotation processes, and the Macquisten process. While these metallurgical inventions deal with base metals, it must not be forgotten that the ores treated almost always contain appreciable quantities of gold and silver, which they will concentrate and save.

A NEAT method of showing the hydrolysis of salts as a chemical lecture experiment is described by Mr. B. L. Vanzetti in the *Gazzetta* (vol. xxxviii., ii., p. 98). An ordinary test-tube is three parts filled with a solution of gelatin coloured with litmus or with phenolphthalein rendered pink by a trace of alkali. A solution of an easily hydrolysed salt, such as ferric chloride, is poured on to the surface of the gelatin after the latter has set. In a short time two zones become visible in the gelatin, one of which, the lower, travelling more quickly through the gelatin, is due to acid, which renders the phenolphthalein colourless; the second zone, at the surface of the gelatin, is coloured by the hydroxide of the base. In the case of ferric chloride this zone is dark brown and opaque, owing to ferric hydroxide being formed. Coloured salts, such as copper sulphate on cobalt nitrate, can also be conveniently used.

FROM the Cambridge University Press Warehouse, Fetter Lane, we have received copies of three forms designed to facilitate the astronomical computations of time, azimuth, and latitude. These forms have been arranged by Messrs. A. R. Hinks and H. K. Shaw, of Trinity College, for use in the Cambridge Geography School, and are somewhat similar to, but more elaborate than, those used for some years past by the students at the Royal College of Science, South Kensington. The first form is for computing time or azimuth from observations of the sun's altitude, and the second for the analogous computation from the altitude of a star, whilst the third is set out for the computation of latitude from circum-meridian observations of sun or star. Such forms are invaluable, especially to those observers who, knowing the general methods, are yet a little hazy as to the details of the computations, for unless one is making and reducing the observations regularly it often occurs that the simplest method of computing is but imperfectly remembered; hence follows loss of time and unnecessary increase of labour; but on these forms every correction, every step in the computation is clearly set out, and it becomes impossible for the observer to forget a correction or to apply a wrong function. In addition to this, each form contains a few useful hints and a diagram to be filled in showing exactly the angles measured. Whilst the forms appear to be otherwise complete, we think it would enhance their value were the entire formula employed inserted, because this would often give the occasional observer a valuable reminder as to the exact form of computation he was employing. The forms are sold in strong envelopes, and the price of each envelope, containing twelve copies of one form, is one shilling net.

MR. THOMAS THORP, of Guildford, has issued a catalogue of the books on botany and gardening, zoology, geology, mathematics and physics, offered by him for sale.

A SUBJECT list of works of reference, biography, bibliography, the auxiliary historical sciences, &c., in the library of the Patent Office has just been published at the Patent Office, 25 Southampton Buildings, W.C.

THE second part of the second French edition of Mr. W. Rouse Ball's "Récréations mathématiques et Problèmes des Temps anciens et modernes" has just been published by M. A. Hermann, Paris. The translation follows the fourth English edition, and Mr. J. Fitz-Patrick has added to it some new subjects of interest, among them being parquetry or tiling, the game of dominoes, and constructions for the squaring of the circle.

OUR ASTRONOMICAL COLUMN.

COMET MOREHOUSE, 1908*c*.—Several observations of comet 1908*c* are recorded in No. 4274 of the *Astronomische Nachrichten* (p. 29, September 23). M. Chofardet, observing at Besançon on September 5, describes it as having a round, nebulous head, of ninth magnitude and 2'·5 diameter, without any definite nucleus. A short, indistinct tail was seen projecting from the head in a N.W. direction. On September 6, 7, and 8, Prof. Abetti, at Arcetri, found the comet to have an oblong nebulous appearance without nucleus, its diameter being 2' and its magnitude 9·0.

Herr Ebell continues the ephemeris published by Prof. Kobold in a previous number, and the following is an abstract therefrom:—

Ephemeris 12h. M.T. Berlin.

1908	α (true) h. m.	δ (true) ° '	log *r*	log Δ	Brightness
Oct. 8	19 57·9	+61 21·4	0·2010	0·0154	4·8
,, 10	19 45·9	+57 59·9	0·1942	0·0100	5·0
,, 12	19 36·1	+54 30·3	0·1872	0·0062	5·3
,, 14	19 28·1	+50 55·3	0·1801	0·0043	5·5
,, 16	19 21·4	+47 17·7	0·1730	0·0041	5·7
,, 18	19 15·9	+43 40·0	0·1657	0·0058	5·9
,, 20	19 11·3	+40 4·2	0·1584	0·0090	6·0
,, 22	19 7·5	+36 32·6	0·1510	0·0139	6·1
,, 24	19 4·3	+33 6·7	0·1436	c·0201	6·0

The apparent positions of the comet among the stars, according to the above ephemeris, are shown approximately

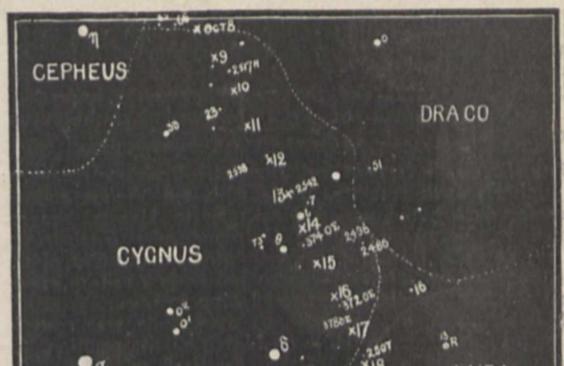


Chart showing apparent path of Morehouse's Comet, October 8–24.

on the accompanying chart; it will be noted that the comet passes quite close to the fourth-magnitude star ι Cygni on October 14. According to an observation made at Copenhagen on September 20, the corrections to be applied to the ephemeris position were +1m. 18s. and −1′·3. Prof. H. Thiele also states that the comet was visible to the naked eye, and that the tail was 1°·5 long with a bend, amounting to 13°, at 12′ from the head.

As pointed out in a letter received from Prof. Dale, the positions given by the Lick ephemeris gradually became worse until, on October 3, the error amounted to about 3°. Elements computed by Prof. Dale differ but little from those computed by Prof. Kobold, whilst an ephemeris with which he has favoured us gives the following positions for October 8 and 14 respectively:—R.A. 20h. 2·8m., dec. +61° 52′·4; R.A. 19h. 31·5m., dec. +51° 40′·8. For the Kiel ephemeris Prof. Dale's observations on October 3 indicated an error of −3·4m. and −18′, whilst later observations indicate that the departure from the ephemeris positions is steadily increasing.

COMET TEMPEL$_3$-SWIFT.—The comet Tempel$_3$-Swift, for which we gave a search-ephemeris in these columns last week, was re-discovered by M. Javelle at the Nice Observatory on September 29. The following was its position at 15h. 9·4m. (Nice M.T.) on that date:—

R.A. = 6h. 44m. 14·6s., dec. = +32° 37′ 55″.

Of the three ephemeris positions given for September 29, this agrees best with that calculated for the mean date (September 30·88) of the perihelion passage. When re-discovered, the magnitude of the comet was 14·0, and its distances from both earth and sun are increasing. Its present position is in the constellation Gemini, and it is apparently travelling, according to the ephemeris, towards Castor and Pollux.

BRIGHT BOLIDES.—A meteor, considerably brighter than Vega, was observed by Mr. W. Moss at Wimbledon Park, at 7h. 4m. p.m., on October 1. Its approximate path was from 213°, +76½°, to 183½°, +78½°, its colour bluish-white, and its velocity medium. At its disappearance the meteor exploded, leaving a short trail. Mrs. E. Gifford, writing from Oaklands, Chard, says that at about 5.45 p.m. on October 1, while looking at the moon, which was to the south-west of her, she saw a shooting star of a brilliant blue-green colour to the east of the moon. It was still broad daylight, and the meteor gave the impression of an oblong patch of light followed by the usual streak.

THE SIXTH SATELLITE OF JUPITER.—Position measures of Jupiter's sixth satellite, made with the Yerkes 40-inch refractor during the period March 24 to May 3, are recorded in No. 4274 of the *Astronomische Nachrichten* (p. 17) by Prof. Barnard; the estimated magnitudes of the satellite were as follows:—March 24, 14·5; April 13, 14·0; April 19, 14·2; April 21, 14·5; and May 3, 14·0.

A faint nebula of the sixteenth magnitude was seen in the same field as the satellite on March 24, its position, for 1908·0, being α = 8h. 26m. 56·58s., δ = +19° 55′ 55″·4.

THE SOLAR ROTATION AS DETERMINED FROM THE MOTION OF DARK CALCIUM FLOCCULI.—In a brief note, appearing in No. 2, vol. xxviii., of the *Astrophysical Journal* (September, p. 117), Mr. Philip Fox gives a few preliminary results obtained by him in the determination of the solar rotation from measurements of the dark calcium flocculi. The evidence so far educed shows that these features are of the same order of height in the solar atmosphere as the hydrogen features, which show a constant period of rotation for all heliographic latitudes. Grouping the latitudes from 20°–25°, 25°–30°, and 30°–35°, Mr. Fox obtains mean diurnal motions of 14°·32, 14°·10, and 14°·14 respectively, thus indicating that the motion is independent of latitude; that is to say, from the results already obtained by Profs. Hale and Adams, these dark calcium flocculi belong to the higher levels of the solar atmosphere. Mr. Fox also confirms the previous observations that the dark flocculi are prominences seen in projection on the disc, but finds that they are not so easily seen as the corresponding dark hydrogen flocculi.

IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell, and was largely attended. The institute was welcomed in an eloquent speech by the Mayor of Middlesbrough, and the president, after acknowledging the welcome, announced that Sir William T. Lewis, Bart., K.C.V.O., had been chosen to succeed him in the presidential chair in May, 1909. Sixteen papers were on the programme, and three mornings were devoted to their reading and discussion.

The first paper read was by Mr. J. E. Stead, F.R.S., who exhibited and described a simple form of inexpensive microscope suitable for the use of foundry foremen and of assistants in steel works.

The next paper read was that by Mr. W. Hawdon (Middlesbrough), on the iron and steel industries of the Cleveland district. He gave a brief review of the iron and steel industries of the Cleveland district during the last quarter-century, *i.e.* since 1883, on the occasion of the last visit of the institute to Middlesbrough, to the present time. The record showed that the iron and steel trade of the district had considerably increased and its position consolidated. The population of Middlesbrough had doubled, but the output of Cleveland ironstone remained about as it had been. In 1899 the first basic open-hearth steel was produced in the district, 10,154 tons being made in that year. The output has rapidly increased, and the question arises, if this increase of basic open-hearth steel continues, where is the ironstone to come from? The best ironstone is rapidly going; there is, however, a large area of stone, of a gradually diminishing richness, or rather of increasing poverty, available for many years to come. If, then, at the end of another quarter of a century the Iron and Steel Institute again visits the district, it may see, should the steel age still be vigorous, a greater output of basic steel and a larger production of pig-iron from native ironstone, which will be won, if not by manual labour, then by one of the many devices which are and will be available for the purpose.

Mr. T. C. Hutchinson (Saltburn) read a paper on the mechanical cleaning of iron ores, in which he considered the most economical method of treating any description of ore by careful selection, and the removal by mechanical means of as much of the impurities as can be easily distinguished by their appearance. He gave his experience in dealing with and smelting Cleveland ironstone when worked for a period of years from the same mine, and tabulated the yield of iron from the ore, and the consumption of fuel and flux required under various conditions due to the irregularity of impurities admixed with ore as delivered from the mines. Many years of careful observation have led him to the conclusion that, whether these impurities are charged into the furnace in larger or smaller percentages as compared with the main bed of ironstone, the coke and limestone requirements and the cost of smelting increase in exact ratio. It is cheaper to pick out impurities mechanically than to melt them out in the blast-furnace. Mechanical cleaning is desirable, and can be applied to all descriptions of ores used in the manufacture of pig iron.

The paper read by Mr. Greville Jones (Middlesbrough), on Messrs. Bell Brothers' blast furnaces, was of great historical interest and educational value. He gave full particulars and dimensioned drawings of the furnaces built by the firm from 1844 to 1908.

A paper by Prof. H. Bauerman (London), on metallurgy at the Franco-British Exhibition, was read by title only, as the author, being a member of the jury, considered that the paper should not be published until the official list of awards had been announced. In connection with this paper, a compilation of analyses of British pig-irons shown at the Exhibition was presented by Mr. Bennett H. Brough. In view of the paucity of published analyses, it forms a very useful work of reference, as the exhibits shown in the Collective Pig-Iron Stand have been carefully selected as typical for the various districts represented.

The paper read by Mr. C. H. Merz (London), on the effect of power supply on the industries of the north-east coast, proved conclusively that manufacturers in that district are quick to avail themselves of new developments or of additional facilities. The generating plant now amounts to 56,000 electric horse-power, and power supply, though of comparatively recent development, has already had a marked effect upon the industries of the north-east coast. A great saving of coal and reduction of smoke have resulted; there is now, apart from the Power Company, practically speaking, no coal burned on the Tyne for power purposes except in chemical factories. The Tyne shipyards and engineering works may be said to have adopted electricity to the exclusion of all other forms of motive power. The application of electricity to all new uses has been facilitated. New industries have been established in the district purely because of the cheap power supply available, and a substantial commencement has been made in the utilisation of the waste heat and gases existing in the area; and in this regard the district occupies a unique position owing to the extent to which its future power requirements can be met by electricity produced as a by-product of two of its largest industries, the making of pig-iron and the making of coke.

Mr. C. Koettgen (London) and Mr. C. A. Ablett (London) read a paper on electrically driven rolling-mills, in which they gave figures showing the power required for rolling different sections, the figures being taken from among the results obtained from 150 rolling-mills. Such results should prove of considerable assistance in settling the correct size of the motor for a new mill for a given output of similar sections.

A paper read by Mr. S. Cowper-Coles (London) was of special interest. Hitherto it has been the universal custom to produce iron sheets, tubes, and wire by a process of smelting the iron, refining, cementation, annealing, rolling, or drawing. The author, however, describes an electrolytic process for making tubes, sheets, and wire in one or two operations from crude or scrap iron, or direct from the ore, without the processes of smelting, rolling, or drawing, at a cost that has hitherto been thought impossible. The process can also be used for the production of seamless cylindrical vessels. The process presents numerous advantages. Finished products can be produced at less cost than by the processes of smelting, refining, and rolling; a product is obtained which does not corrode so readily as steel at less cost; the process can be worked economically when no coal is available, but water-power only; iron ore that is useless for ordinary smelting operations can be advantageously utilised by the electrical process; the process is a power process, and utilises but little labour; small units can be worked economically; the process is more cleanly and healthy than the ordinary operations; and little or no scrap is formed.

Mr. E. H. Saniter (Rotherham) submitted a paper on a test for ascertaining the relative wearing properties of rail steel. The principle of the testing machine devised is that there is a round test-piece revolving a fixed number of revolutions and rotating by friction the inner ring of a ball-bearing loaded with a fixed weight, the action being similar to that of a wheel rolling on a rail.

The paper communicated by Mr. A. E. Pratt deals with the possibility of extending the utility of the modern metal-mixer by carrying out in it greater preliminary purification than is usually the case in present practice. The bearing of these suggestions on the development of the open-hearth process is also considered. Lastly, the thermo-chemistry of open-hearth ore reactions is discussed.

Prof. W. A. Bone (Leeds) and Dr. R. V. Wheeler (Manchester), who in 1907 read before the institute a very important paper on the use of steam in gas-producer practice, read a paper describing further experiments demonstrating that with still lower steam-saturation temperatures a most effective combination of high rate of gasification with thermal efficiency can be continuously maintained over long periods of time, under ordinary works conditions, furnishing a rich gas of high carbonic oxide content, and eminently adapted for either power or heating purposes.

The paper read by Prof. H. E. Armstrong, F.R.S., on the scientific control of fuel consumption, was a plea for the introduction of a new attitude towards problems of combustion and of fuel economy, an attitude of understanding based upon sympathetic and serious contemplation of the phenomena. In order that economies may be effected, it will be necessary to secure the services of a special class of chemists—of men gifted with real chemical feeling qualified to study the problems which the consumption of fuel affords. Such men must be properly paid, and in every way rank on an equality with members of the engineering staff. They should have enough knowledge of engineering to be in full sympathy with their engineering colleagues, who in turn should be sufficiently versed in chemistry to appreciate the chemists' behests.

The chemist was also championed in the paper on the chemical control of the basic open-hearth process contributed by Mr. Alfred Harrison (Warrington) and Dr. R. V. Wheeler (Normanton). Starting with the proposition that the basic open-hearth process is essentially a chemical problem, they indicated how far the chemist could control the process, and detailed a scheme for the complete following of the reactions taking place.

The paper presented by Prof. E. D. Campbell (Ann Arbor, Michigan), on the constitution of carbon steels, was of a most suggestive character. He reviewed the efforts that have been made to interpret the phenomena of the hardening and tempering of steel in the light of the phase rule. The analysis of the carbides obtained from martensite and from troostite in his laboratory appears to indicate marked dissociation, ionic as well as molecular, in the carbides from martensite, while the analysis of the carbides obtained from troostite would seem to indicate almost complete association and polymerisation of the dissolved carbides, since the nitro-derivatives of the troostitic carbides are as dark in colour as those obtained from equal amount of carbides derived from pearlite. These results would indicate the probability that when martensite is heated from 0° C. to 200° C. there is progressive association of ionically dissociated carbides, and polymerisation of the carbides of lower molecular weight into those of high molecular weight. This polymerisation of dissolved carbides is apparently complete by the time the metal has been converted into troostite. This conception of the changes which take place in the gradual conversion of martensite into troostite offers a simple and rational explanation of the progressive darkening of martensite with rising temperature from 0° C. to 200° C., and for the increase of what Heyn and Bauer term free carbon, but which is probably a condensation product of olefines of high molecular weight. It is suggested that there does not seem to be any inherent reason why the complete substitution of hydrogen by iron should prevent carbon atoms from assuming relations to each other similar to those which they hold in hydrocarbons. The conception of the carbon compounds of iron as metallic derivatives of hydrocarbons suggests a possible explanation of many unsolved problems in the metallurgy of steel, as, for instance, how other elements, too small in amount in themselves to affect profoundly the properties of the steel, may enter into the carbon compounds, and, by altering their constitution, bring about effects on the steel as a whole entirely out of proportion to the amount of the element present.

The paper communicated by Prof. H. C. H. Carpenter (Manchester University), on the freezing point of iron, showed that in the present state of pyrometric science the freezing point of iron is best defined either on the thermoelectric or the optical scale. The mean value calculated from several closely agreeing determinations made under entirely different experimental conditions by the thermoelectric method is 1505° C. on the thermoelectric scale. This corresponds to 1519° C. on the optical scale, which is probably the nearest approximation to the true value at present available. The optical determination of the freezing point by a surface-radiation method does not, in its present condition, yield more than an approximate value, which is slightly lower than that obtained by the thermoelectric method, viz. 1505° C. The freezing point is independent of the atmosphere in contact with the iron, whether this be oxygen, nitrogen, air, carbon monoxide, carbon dioxide, hydrogen, or mixtures of these.

Mr. A. Jouve (Paris) contributed a paper on the influence of silicon on the physical and chemical properties of iron. In it he devoted special attention to the modification of the magnetic properties and of the chemical properties in relation to the resistance of iron to the action of chemical reagents. He gave examples showing that in cases where the silicon added to the iron attains a sufficiently high percentage the magnetic properties diminish, and the resistance to the action of acids increases with the proportion of silicon.

During the meeting visits were paid in the afternoons to the various iron works in the district and to the new graving-dock works on the river Tees. The social functions included a conversazione in the Town Hall, a ball given by the reception committee, a garden-party given by Lady Bell, a special performance at the Grand Opera House, luncheons in the Town Hall, and a luncheon given by the Tees Conservancy Commissioners at the Fifth Buoy Lighthouse.

FISHING AND SEA-FOOD SUPPLIES OF THE ANCIENT MAORI.

In the second Bulletin of the Dominion Museum of New Zealand, the director, Mr. A. Hamilton, contributes an elaborate monograph on the fishing and sea-food supplies of the ancient Maori, based upon the investigation of numerous coastal kitchen-middens and camp sites. The importance of these sources of food supply is clearly illustrated by the Maori mythology, which abounds in tales of sea adventure and monsters of the deep. Among the mammalia, the only class affording food or valuable spoil, except the native rat and the imported dog, was the marine fauna, including the fur-seal, sea-leopard (*Ogmorhinus leptonyx*), and the sea-lion (*Macrorhinus leoninus*), of all of which traces are found in the middens in the form of bones and ornaments made from their teeth. One of the most valued prizes was the great sperm-whale (*Physeter macrocephalus*); but other members of the same group, such as the black-fish (*Globiocephalus melas*), were used for food. Of mollusca the consumption must have been enormous, one of the many middens consisting of shells of the Maori pipi (*Mesodesma novae-zealandiae*) being 340 feet long and more than 4 feet high. Many of these shells, particularly that of the beautiful Holiotus iris, were used in the preparation of ornaments. Among the crustaceans, the most valued were the red crayfish, crabs, and shrimps. Sea-urchins and many kinds of seaweed were collected from the rocks.

Fig. 1.—Large Wooden Hook for Shark.

The variety of fish-hooks in greenstone, bone, or steatite is astonishing. Some objects of similar form seem to have been used as amulets, over which charms were recited to bring luck to the owner when he went fishing. This explanation accounts for some curious conventionalised examples, the use of which is otherwise not apparent. Like these are the remarkable greenstone pendants in the shape of an eel, which seem to have been employed for a similar purpose. The luck of the fishing community was also embodied in certain stones. When one of these was stolen, so recently as 1894, the natives attributed an unsuccessful season to its loss.

In the sandhills many tools have been recovered which were used in preparing bone fish-hooks. The material was worked into shape by the use of a drill moved by the alternate pulling of strings attached to the top of the spindle, the end of the drill being armed with a point of flint or quartz. When the hook was roughly shaped it was finished with rude sandstone files. The smaller hooks are usually formed of a single piece of bone, only one remarkable specimen of a small composite hook having been recorded, though large examples are common. Sharks were captured in a net or with an immense wooden hook, young roots or branches being sometimes artificially bent while growing for this purpose. Still ruder are the double-pointed pieces of albatross bone, round which the bait being wrapped they were used as "gorges"—one of the most elementary of fishing implements, common in the European lake dwellings. When the explorer and whaler came upon the scene these bone and stone hooks were quickly replaced by those of iron or copper; but the ancient forms were reproduced in the new materials. A curious appendage to a fishing-rod is a carved figure to the lower part of which a number of valves of shell were attached. These rattle when a fish takes the bait and attract the attention of the fisherman. The net-sinkers form a large class. One specimen at Auckland, formerly described as a sea-god, seems to belong to this class, the sinker being worked into a semi-human shape and used to produce magical effects. The various kinds of modern fish-baskets and nets display considerable ingenuity and constructive skill.

Fig. 2.—Figure carved on a fishing-rod.

Among the inland fish the ancient Maori depended chiefly upon the eel, which more than any other kind of food provided the much desired fat. For its capture they constructed huge works, only excelled in magnitude by their fortifications, in the shape of canals and weirs. They were well acquainted with the art of drying superfluous fish in huge earth ovens erected on the beach, and heated with a special kind of wood. When sufficiently cooked, the fish were taken out, as far as possible unbroken, placed on raised stages to dry, and finally packed in large flax baskets for winter use.

Mr. Hamilton's monograph, which is well illustrated throughout, is an interesting contribution to the study of the commissariat and industries of primitive man.

CHEMICAL DATA FOR THE GEOLOGIST.[1]

Geology, as has sometimes been said, is less a distinct science than the meeting-ground of all the sciences as applied to a distinct object, viz. as elucidating the history of the earth and its inhabitants. The working geologist therefore feels, more than most of his brethren, the necessity of gaining some acquaintance with numerous branches of knowledge in which he cannot pretend to be a specialist. In particular, the problems of physical geology and petrology are closely bound up with the modern developments of inorganic chemistry, and require not only a familiarity with general principles, but a knowledge of specific results, scattered through the pages of many journals and transactions of societies.

It is with results, rather than with principles, that the work before us is concerned; and the author has gathered into one volume a large body of information which is not to be found elsewhere in collected form. The work is necessarily that of a chemist rather than a geologist, but

1 "The Data of Geochemistry." By Frank Wigglesworth Clarke. Bull. No. 330 United States Geological Survey. Pp. 716. (Washington, 1908.)

Mr. Clarke's mineralogical researches and his connection with the laboratory of the United States Geological Survey well qualify him for a task of this kind.

The volume begins with a brief notice of the chemical elements, as regards their distribution and relative abundance in the known part of the globe, a subject to which the author has himself made some interesting contributions. Then follows a valuable summary, from the chemical point of view, of the nature of the atmosphere, the waters and saline contents of rivers, lakes, seas, and springs, and the gaseous constituents of igneous rocks, volcanic emanations, and fumeroles. A large number of analyses of air, waters, and gases are collated, and their bearing on some of the questions of physical geology indicated, with an occasional discursus upon such subjects as the composition of the primitive atmosphere and the source of volcanic water and gases.

This occupies one-third of the volume. About half as much space is devoted to igneous rocks and their constituents. In this department any trustworthy data, beyond chemical analyses, are at present very scanty. The admirable work of Day and others at Washington, while providing us with accurate thermal constants for a few of the rock-forming minerals, has at the same time discredited practically all previous results in the same line. It appears, for instance, that the melting-point of anorthite, one of the most easily crystallised minerals, has been underestimated to the extent of 400°. The account here given of the several rock-forming minerals is accordingly little more than what is to be found in any text-book, excepting that the information concerning artificial reproduction of the minerals is brought down to date. The space might have been more profitably filled by a section written on the lines of the "Synthèse des Minéraux et des Roches" of Fouqué and Michel-Lévy. The fifty pages dealing with igneous rocks, under a peculiar scheme of classification, might well have been omitted. No useful purpose is served by selected analyses of rocks in a work of this kind, when complete collections of analyses are easily accessible.

The remaining chapters treat of the decomposition of rocks, sedimentary and detrital rocks, metamorphic rocks, metallic ores, the natural hydrocarbons, and coal. Under the last two heads especially there is a large amount of information which we have not seen elsewhere brought together in so complete a form.

The United States Geological Survey, taking a liberal view of its province, has from time to time issued publications dealing with general geological subjects, and among these the one now before us will take its place as a useful work of reference. It will be the more valued because the material is presented in a concise form, and the volume is of such size as to be easily handled without the aid of a lectern.

A. H.

THE INFLUENCE OF HUMIDITY ON RESISTANCES.

MESSRS. ROSA AND BABCOCK, at the Bureau of Standards, found that manganin wire resistances used in resistance boxes varied according to the time of the year; for instance, in summer they were 0·015 per cent. to 0·025 per cent. higher in value than they were in the same temperature in winter. These experimenters explain this periodic variation by the fact that with increased relative air humidity the shellac, especially that between the metal tube and the wire, swells; the base on which the wire is wound consequently increases in diameter, and the forces thereby created cause the resistance wire to expand elastically. With decreasing humidity the shellac gives off moisture and shrinks, the pressure on the wire is relaxed, and the resistance decreases.

Tests just completed, and the results published (*Zeitschrift für Instrumentenkunde*, August), by the Reichsanstalt go to confirm this view, but the variations observed there are much slighter than those found at the Bureau of Standards. The tubes on which the wire is wound had hitherto been covered, first of all, with a sheet of silk, this being well covered with shellac; but in view of the humidity effect, tests were made with a number of specially prepared lacquers, but, so far as obtaining one which was impermeable to moisture was concerned, the experiments were futile. The author has therefore tried the effect of rendering the tubes to a certain degree elastic in order to combat the effect of the expansion mentioned, and has found that by providing them with longitudinal slots, and also dispensing with the preliminary covering of silk, a considerable advance has been made in this connection. In one coil mentioned in the results the six slots projected on both the upper and under sides to the extent of 3 mm. beyond the windings, while in another tube the slots on the upper side projected 1 cm. beyond the wire, reaching to the same distance as the wire on the under side. These coils were measured immediately after construction, and attained a constant value in a much shorter time than did the coils constructed hitherto.

With a view to obtain the maximum accuracy, the author also suggests that the resistance boxes should be continually filled with paraffin oil of a density of about 0·86. Whether better results will really be obtained in this manner is at present the subject of experiment.

The test coils experimented on up to the present are, without exception, the long, thin form usual in resistance boxes. A few slots will not suffice for rendering more elastic the short, wide tubes used for standard resistances. It must remain for tests to ascertain what is the best form for these coils, and a research is already in hand with this obect.

The paper gives a full description of the experiments, and contains a number of curves showing the variations of a number of coils at the Reichsanstalt.

THE OPENING OF THE MEDICAL SESSION.

THE medical year of the schools of medicine in London and the provinces may be said to commence on or about October 1, and the opening of the session is in many instances made the occasion for the distribution of prizes, the delivery of addresses of welcome and advice, and the re-union of old friends at the "old students' dinners."

At University College, after the distribution of medals and prizes by the Dean, Dr. Batty Shaw, Sir Edward Fry addressed the students and their friends. He first offered his congratulations on the admirable buildings in which the work of the school is now carried on, and then made some remarks on the professional ideal. The advantage of a profession over a trade is that it sets a higher ideal before a man; it requires of him to benefit the persons for whom he acts without regard to any private interest of his own. The legitimate gain which must accrue will be a secondary object rather than a primary one. It is on this ground that, quite justly, the world expects of professional men a higher standard of intelligence and of morals than it requires of the mere tradesman. Every true student should be a student all his life through; he should be able to say with old Solon, "I grow old always learning many things." Finally, Sir Edward touched on the relation of the medical profession and the State, pointing out that it is obvious that the medical profession is becoming more and more occupied with public business, and that its aid is being more and more invoked by the governing authorities. He referred to the investigations that are being made by the direction of the Privy Council, the various commissions that are being issued dealing with tuberculosis and other aspects of disease, the scheme now being put into practice for the medical examination of scholars in the primary schools, and the appointment of medical officers of health throughout the country. The medical profession is being drawn in an increasing degree closer to the work and objects of the State. However close that relationship may become in the future, it is hoped that the medical profession will strive to maintain its independence, and will never believe that it is to be subservient to the State.

At King's College Dr. Alexander MacAlister delivered an address on fifty years of medical education. After referring to some of the salient discoveries during this period, he pointed out that each decade since has witnessed a lengthening of the course, an increase in the number of subjects of examination, and a greater stringency in the standard required. The modern curriculum is an attempt to realise a scientific ideal. At every stage practical work goes hand in hand with the teaching of theory. The result is that, even with the present five years' minimal course, anatomy, instead of being, as it used to be, the one dominant subject of drill, has to take its place as one out of five sciences in which laboratory work has to be done. He then made some remarks on the mystery of life, holding that the physicochemical hypothesis of life which has come into vogue is inadequate. Evolution is the name we give to the modal process of growth, but we are left where we were as regards the mystery of origins, or of the forces by which this process is brought about and directed. But if the physicochemical hypothesis is incompetent to account for the mysteries of organisation, it is still more inefficient as an explanation of the psychological processes of consciousness.

Prof. Myers also delivered an introductory lecture on the aims and position of experimental psychology, at the close of which he dealt with what he described as the inadequate provision of the University of London for the teaching of psychology. The subject is recognised in six separate courses of study in the University; this distribution is harmful to its progress. It is an independent science with methods which are distinctly its own. Yet there is no body of professed psychologists within the University. He pleaded for the institution of a board of studies in psychology in order that the teaching of the subject may be reorganised and coordinated. Describing the provision made for the teaching of psychology on the Continent and in the United States, Dr. Myers showed that London is conspicuously backward, and he said there are not more than half a dozen medical men in the country who could carry out such observations upon a patient as would satisfy a psychologist.

The Huxley lecture, on recent advances in science and their bearing on medicine and surgery, was delivered at Charing Cross Hospital by Sir Patrick Manson, F.R.S. The lecturer dealt first with the geographical limitation of disease and the factors causing it—local and climatic conditions, the presence of other forms of life which act as intermediaries for the germ, &c. The principal tropical diseases are caused either by protozoa or by helminths. So far as we accurately know, none of the disease germs of strictly tropical diseases is bacterial. Several bacterial diseases which are often classed as tropical—for example, cholera, certain kinds of dysentery, leprosy, plague, Mediterranean fever, &c.—are not really tropical. Experience has shown that these diseases can flourish in any climate. It is only because those hygienic and social conditions most favourable to their spread are met with at the present day in greatest perfection in the tropics that they are conventionally regarded as tropical.

At St. George's Hospital Dr. Slater took as the subject for his address the laboratory in medical education and practice, in which he demonstrated the growth of knowledge of morbid states consequent on investigations carried out in the laboratory. It is quite certain that if the maximum benefit is to be derived from the laboratories, consultations between the clinician and the laboratory will have to be more resorted to.

At the Middlesex Hospital Mr. Rudyard Kipling presided, and Dr. Kellas delivered an address on the development of medicine as a science, giving an interesting account of the history of medicine from the earliest times.

At St. Mary's Sir John Broadbent remarked on the great advances that have been made in medicine, as in surgery, in recent years, and deplored the tendency of modern times to fly to the so-called remedies for every ill now advertised widely in the daily Press.

Addresses were also delivered at the London School of Medicine for Women by Dr. Sainsbury; at University College, Bristol, by Sir Rubert Boyce; at the University of Manchester by Sir Clifford Allbutt; and at the Pharmaceutical Society by Mr. Harwood Lescher.

THE BRITISH ASSOCIATION.

SECTION L.

EDUCATION.

OPENING ADDRESS BY PROF. L. C. MIALL, D.SC., F.R.S., PRESIDENT OF THE SECTION.

Useful Knowledge.

I PROPOSE to speak to you about useful knowledge, and you will, I think, admit the importance and the appropriateness of the subject. But you may be surprised that I venture upon so wide a theme. For my part, I maintain that the extent of a subject gives no notion, however vague, of the time required to discuss it. If you have a quarter of an hour and a sheet of paper you may employ them with about equal probability of success in delineating a hand's breadth of greensward, or the British Isles, or the whole world. Bossuet handled universal history from his own point of view in a volume of no more than six hundred octavo pages, and Buffon[1] remarks, quite truly, that every subject, no matter how vast, can be treated in a single discourse. You will observe with satisfaction that I deny myself the commonest and most plausible excuse for an unduly prolonged address; that, I mean, which pleads the magnitude of the subject.

I do not wish to exaggerate the importance of useful knowledge. It is not everything, nor yet the highest thing in education. There are things which we rarely mention in a British Association section, and which are perhaps best left undiscussed, except where there is entire sympathy between speaker and hearer; some of these stand above useful knowledge of every kind. But the fact that useful knowledge occupies nearly all the school-time shows its practical importance, and disposes us to welcome any means of making it more effective.

Book-learning.[2]

The knowledge of books may be an excellent form of useful knowledge; it may also, when it strives merely to record and remember, be unproductive and stupefying. Let me give you an example, by no means an unfavourable one, of the book-learning which becomes sterile for lack of method and aim. My example shall be the elder Pliny, Pliny the naturalist, who lost his life in an eruption of Vesuvius, and whose many virtues were piously described by his nephew, Pliny the younger. The elder Pliny wrote a voluminous Natural History, and left behind him 160 books of unused extracts. His appetite for reading was insatiable. Reading filled all the hours which could be spared from public duties or snatched from sleep. Once, when a friend interrupted the reader to correct a mispronunciation, Pliny asked, "Did you not understand?" "Yes." "Then why did you interrupt? You have made us lose ten lines." The Natural History compiled during years of such reading is wholly uncritical; any testimony is good enough for the most improbable story. We look in vain for interpretation, combination, or inference. The facts are indeed rudely sorted, usually according to subjects, but sometimes alphabetically. The chief use of Pliny's Natural History has been to promote the fabrication of more books of the same kind.

Pliny, with his unlimited appetite for knowledge and his very limited power of using it, might seem to have been taken as a pattern by scholars. Like him, they have amassed knowledge in heaps. It has been the ambition of many scholars to read everything that was worth reading, and to fill great volumes with the imperfectly digested fragments.

In the ages of learning, the schoolmaster too became a pedant. His chief duty he supposed to consist in furnishing his boys with knowledge which they might some day

[1] "Discours à l'Académie."

[2] In the preparation of this Address I have been much embarrassed by the inexactness of the terms used to denote different studies. Some, such as science, literature, &c., include both process and product, which is as if we had but one name for weaving and cloth. The accepted names of the divisions of knowledge are neither exhaustive nor mutually exclusive; they are not so much logical terms as names of occupations, each of which might well occupy one man's time. We acquiesce in such anomalies because we feel the need of brief and comprehensive expressions, and find that bad definitions are not so intolerable as cumbrous and unfamiliar terms.

want. If it were not that Nature has endowed schoolboys with a healthy power of resistance, their memories might have come to resemble the houses of those who believe that whenever they throw a thing away they are sure to want it again—houses in which room after room is so packed with antiquated lumber as to be uninhabitable.

The Renaissance called up men who made a vigorous protest against unused learning. Rabelais put into grotesque Latin his opinion that the most learned scholars may be far from the wisest of men.[1] Montaigne said over again in pointed phrases what common-sense people had been saying for ages, that he who knows most is not always he who knows best; that undigested food does not nourish; that memory-knowledge is not properly knowledge at all.[2] Erasmus wondered at the practical ignorance of the scholars of his own days—"Incredibile quam nihil intelligat litteratorum vulgus." Locke refused the name of knowledge to book-learning; real knowledge, he held, was mental vision. In the educated man he valued virtue, wisdom, and breeding (manners), ranking them in this order; learning came last of all.[3]

Happily for us, a great deal that we once knew and might foolishly wish to keep quickly fades from the memory. I picture to myself a stream gliding past, and bearing along a miscellany of facts any of which may possibly be useful at some future time. Now and then we stretch out a hand and grasp something which takes our fancy. In nine cases out of ten we drop it immediately. Only a small fraction of the knowledge which enters the mind of an inquisitive person is kept for so long as a month.

What we remember so greatly exceeds what we can use that we need not deeply regret the loss that is always going on. When people explain to us how much valuable substance is wasted by want of care in selecting and preparing our food, I reflect that all of us consume twice or thrice as much food as we can do any good with, and then I am consoled. It is not nearly so necessary to know more things as to know them better, to know what to do with them.

No doubt we often find it necessary to recall a multitude of small facts, in order, it may be, to elicit a general conclusion or to produce a telling argument. But is it wise to prepare years in advance by storing all the facts in the memory? I cannot think so. The study of the bodies of animals teaches us that muscle and nerve, which are easily fatigued and require an abundant blood-supply, are never employed in Nature where bone or tendon will serve. Exercise of the memory involves nervous strain, and after an early age a considerable nervous strain. It is more economical and more business-like to employ mechanical contrivances rather than brain-tissue for such purposes, to leave the vast mass of useful facts in grammars, dictionaries, and text-books, and to collect those for which we have a present use in the notebook or the card-index. There is another appliance which the serious student finds almost as useful as the notebook or the card-index—I mean the waste-paper basket.

The history of learning warns us that it is not good to lay up in our memories a great store of knowledge the use of which lies far in the future. Apply to knowledge what moralists tell us about money. It is only the money that you may expect to put to use within a reasonable time that does you any good, and the same holds true of knowledge. Unused knowledge, like unused money, becomes corrupt. Uncritical, ill-mastered knowledge is at its best a knowledge of useful things, which, as Hazlitt points out,[4] is not to be confounded with useful knowledge.

If I felt it necessary to show that all book-learning is not futile, I might dwell upon the great subjects of languages and history. But you will gladly allow me to pass on to branches of useful knowledge with which I am more familiar.

[1] 'Magis magnos clericos non sunt magis magnos sapientes" ("Frère Jean des Entommeures in Gargantua," i. 39).
[2] "Essais," i. xxv.
[3] Rabelais, Montaigne, and Locke have been collated by Quick in his edition of the "Thoughts concerning Education."
[4] "Round Table," Classical Education.

Science.

It is the function of science to produce verifiable knowledge. Science achieved her earliest successes by investigating the simplest properties of tangible things—number, form, uniform motion. Here she learned how to combine the knowledge of many concrete facts into general statements, which (to the confusion of thought) we call scientific *laws*. Science applies her general statements to new cases, using facts to make general statements, and general statements to discover or verify facts, so that a considerable part of scientific knowledge is in perpetual use. Science is no longer content with the study of simple properties and tangible things. She will consider facts of every kind as soon as she can find the time. There is no hope of withdrawing from scientific treatment any kind of experience which the human senses or the operations of the human mind furnish; to be safe from the inroads of science you must betake yourself to some study which does not meddle with facts.

Generalisation involves incessant reference of effects to their causes. Facts can only be ill-classified and superficially generalised so long as the causes of the facts remain uninvestigated. Science of any good kind sets up, therefore, the habit of methodical inquiry and the habit of reasoning—productive reasoning, we might call it, to distinguish it from the reasoning of the schools. The best examples of productive reasoning are to be found in the investigations of science, and especially of those experimental sciences which deal with simple tangible objects the properties of which can be studied one at a time.

The virtues of science are exactness, impartiality, candour. Scientific impartiality means the determination to accept no authority as binding except the assent of all competent persons. Scientific candour means perpetual readiness to revise opinions which are held in respect. Loyalty, except of one kind, loyalty to herself, science has no use for and does not cultivate.

I think it is true, but you can judge as well as I, that during the last four centuries there has been no generator of useful knowledge at all comparable with science.

Spencer's Estimate of the Place of Science in Education.

Herbert Spencer has raised the question: What knowledge is of most worth? He considers knowledge in its bearing on life and health, on the gaining of a livelihood, on citizenship, on artistic production and enjoyment; lastly, as a means of discipline. The answer which he gives under each head is "Science"; that is his verdict on all the counts. A decision so clear, which is, moreover, powerfully and even eloquently supported, cannot fail to be impressive. It is naturally welcome to those who are devoted to the cause of science, and we can all see that, if accepted, it will simplify many troublesome questions. Will it not guide us in choosing a school staff, in drawing up a curriculum, in fixing the future occupations of our children?

But we must first scrutinise the verdict itself. Let us begin by putting a preliminary question so as to remove all risk of ambiguity. Who or what is to possess the knowledge the worth of which is to be estimated? Spencer seems to contend that for everybody and in all possible circumstances science is that knowledge which is most valuable, but this is a conclusion hard to receive. There are persons who are intellectually unfit to acquire the scientific habit of mind, or who follow an occupation incompatible with any but a light and recreative study of science. Suppose that a youth is wholly uninterested in science; or that after fair trial he shows no capacity for it; or that he is eager to become a poet; or that he will inherit a lucrative business in which science plays no part; would not these propensities and circumstances modify our choice? I cannot believe that Spencer was so unpractical as to deny them any weight at all. Is it possible that he was thinking of mankind, of the British nation, or of some other large collection of men; that it is to the nation or the race that science will prove itself of most worth? If this is the right interpretation, we have some ground for blaming Spencer's neglect to mention so important a qualification. Those who admit that the nation requires scientific knowledge beyond knowledge of any other kind are not compelled to maintain that the individual man must give his chief attention to science. A minute division of labour, intellectual as well as manual, is necessary in modern life, and we become every day more dependent upon other people's knowledge. An elementary knowledge of many sciences, such as Spencer valued and himself possessed, steadily becomes less attainable, and less applicable to real business; less attainable, because the standard is always rising; what was a respectable acquaintance with science in the days when Spencer was educating himself would now be thought no better than a smattering; less applicable, because business now requires and commands the science of experts. The instances which used to be quoted half a century ago of workmen who attended a course of chemistry in a mechanics' institute, and straightway suggested improvements in the manufacturing processes upon which they were engaged, have become rare, and will soon disappear altogether. Business demands the very best science that the age can supply, and it can afford to pay high enough to get it. Obviously the best knowledge of any kind can only be possessed by a few.

Spencer seems to expect that every intelligent mother should enjoy a knowledge of human physiology which will be a sufficient practical guide for the rearing of a family, but here, too, I have my doubts. Since the first publication of his essay the requirements of human physiology have risen in a surprising degree. The knowledge that can be got by reading even so admirable a text-book as Huxley's "Lessons" does not nearly suffice for the practical adviser. On this point I can speak with experience. When I was preparing for biological work I dissected the human body, took out courses in physiology, and walked the hospital. But this tincture of professional knowledge, though better than that which any elementary or secondary school could supply, has never proved applicable, except to the least serious of emergencies. A little knowledge may indeed be dangerous when it is applied to the diagnosis of disease or to sanitary construction.

Those who agree with me that the science which is applicable to industry or to public health is steadily growing harder of attainment will not, I hope, turn this into an argument for restricting the study of science to a few. The elementary science of the school, if good of its kind, is valuable for its effect upon the character and the intelligence; it is necessary for the timely discovery of young people who can be trained to carry on scientific discovery; and it engenders a sympathy with science which is of high importance to the State. If the science of the school does no more than make the phenomena of everyday life a little more comprehensible and a little more interesting, it will fully justify itself.

Spencer would, I feel sure, have admitted that even when science is to be the chief occupation of after-life, it should not occupy more than part of a well-ordered course of school-study. The chemist or physiologist often requires to express his own meaning by speech or writing; it will be highly advantageous that he should express it clearly and vigorously. He must get effective command of at least one foreign language. He ought to know enough mathematics and drawing to make his own calculations and sketches. He ought to have learned how to use books. Spencer does not exclude literature and the fine arts from education, but in his scheme they are not to claim very much. "As they occupy the leisure part of life, so should they occupy the leisure part of education."

I do not suppose for a moment that this passage was written with the intention of pouring contempt upon literature, and it is really appropriate to the current fiction which to-day is, and to-morrow is cast into the oven, but what insensibility to the claims of the higher literature it betrays! "On traite volontiers d'inutile," says Fontenelle, "ce qu'on ne sait point; c'est une espèce de vengeance."[1]

These considerations move me to reject Spencer's verdict. There is not, and cannot be, a scale of usefulness by which everybody's choice can be at once determined. Before deciding what the schoolboy is to study we must inquire what are his aptitudes, inclinations, and opportunities. And the importance of science, which I do not think Spencer has exaggerated, will be fully recognised when every nation and city, every profession and trade, every person and interest, can be guided as often as need arises, not by their own scientific judgment, but by the judgment of scientific experts.

Preliminary Scientific Medical Studies.

Everyone agrees, in the abstract, that scientific information, the heap of scientific facts, is a small matter in comparison with scientific method and the scientific spirit. We do not, it is true, give effect to our convictions in practice. The teacher of science still loads the memory with facts; the examiner in science still passes or ploughs according to the quantity of facts that the candidates have got up. It requires an effort to keep hopeful, but we must go on steadily pointing out what we take to be the right way. The reformers of science-teaching are now bent upon such improvements as these: they wish to see a greatly improved synthesis of the student's knowledge, so that the things that he learns in one place and from one teacher should be intimately combined with what he learns in another place and from another teacher. Further, they wish to see a large extension of personal inquiry and personal verification of the fundamental scientific facts. It is thus, we think, that the future man of science will become possessed of a compact and harmonious body of useful knowledge, which may in favourable cases incorporate with itself the experience of after-life, and exhibit the incomparable virtue of healthy natural growth.

I will continue the discussion a little further with reference to the great problem of the scientific education of the medical practitioner, which has occupied the attention of the scientific world during the whole time of my long professorship, and still seems far from permanent settlement. Medicine is at present our one great scientific profession. It brings science into the daily life of every one of us, and employs it for the protection of some of our dearest interests. The scientific basis of medical knowledge should be sound, compact, well mastered, and, if possible, productive. I will go on to consider what it actually is, forming my opinion upon thirty years of experience in teaching elementary science to medical students.

Let me begin by making a concession to those who think that things are pretty well as they are. Remembering distinctly what the medical student was thirty years ago and more, I find that the first-year's university student of medicine at the present day is in all respects a better man, more serious, more enlightened, more capable. I find too that his preliminary scientific course seems to do him real good. It is far from perfect, but it is a great improvement upon anything that existed in the remote days when I was myself a first-year's medical student. The labours of the last thirty or forty years have not, in my opinion, been thrown away.

Nevertheless the preliminary scientific studies of the medical man are far from being as effective as they ought to be. Much of his time and effort are spent in laying up heaps of knowledge for which he is expected to find a use at some distant day. The items of scientific knowledge still require to be firmly bound together, and indissolubly associated with professional ideas and with professional exigencies. It is only close association with the work of the practitioner that can keep his knowledge alive.

The preliminary scientific course should give practice in the methods of chemistry, physics, and biology. It should prove by definite evidence characteristic scientific truths. Lastly, it should be closely related to medical practice. Looking round for an inquiry which will satisfy these conditions, one inevitably thinks of the teaching of Pasteur, which is now recognised as fundamental in medicine, surgery, and hygiene. Is it possible to give the future medical practitioner a firm grip of that teaching? I think it is. The first part of the preliminary scientific year I should treat as preparatory. It ought to acquaint the student with the methods which chemistry, physics, and biology employ for the establishment or the criticism of scientific statements. Methods of detecting and estimating; of observing small indications; of drawing; of

[1] Dr. Duncan's "Life" furnishes proof of the slightness of Spencer's obligations to literature.

recording results; of putting questions and bending the mind to their solution, should receive particular attention. The multifarious learning of the text-books should be put aside in order that undivided attention may be given to investigation and proof. I would leave it to the teachers concerned to supply the appropriate training, and to certify that it had been got. The latter part of the same year might be concentrated upon the close study of a very few of those agents which set up fermentation and putrefaction and contagion. A simple practical examination would test the reality of the knowledge of ferments actually gained; I can only hope that the examiners would not expect encyclopædic knowledge. This is not the place for the discussion of details.

Technical Education.

Of technical learning I must say but little, and that little must be said with reserve. For my only acquaintance with the subject is indirect, and arises from long connection with a city and university where technical education is prominent. I hope not to express presumptuous opinions on a kind of useful knowledge which I know so superficially.

Technical education may be pursued in at least three ways: (1) We may seek to qualify the pupil for his calling by a thorough training in some science or art, and then, by the application, under the guidance of an expert, of that science or art to a particular industry. The experience of at least two generations seems to show that this method is really effective; it does what it professes to do. (2) The second method aims at no more than supplying information directly applicable to the industry in question. Surely this is the least profitable of the three. The information is not accurately lodged, either in the memory or in the note-books of the students; it soon becomes obsolete in consequence of the advance of knowledge; and it does little to cultivate intelligence or the power of doing. Where intelligence and the power of doing already exist, mere information may be valuable, but the best storehouse of information is the printed book. (3) Lastly, we may aim at nothing more than facility by repetition. Such practical arts as reading, writing, drawing, needlework, and cookery are largely acquired by imitation and constant practice. Skill in these arts is a tool, the profitable application of which depends much upon the intelligence and enterprise of the possessor. Independent attempts to meet difficulties, friendly criticism of these attempts, questioning about the causes of failure, are the expedients which a wise and experienced teacher, ever at hand, would employ. Such a teacher is of course rarely to be had, but is now and then found in a sensible mother. Perhaps the best substitute for the sensible mother would be plain, practical lessons on elementary science, such as the Edgeworths, Dawes, and Henslow used to give.

Literature.

Literature differs from most kinds of useful knowledge in having an immediate value. Like beautiful scenery, health, liberty, friendship, and other felicities of life, it is good in itself, apart from the advantages which it brings. Nevertheless, literature is not satisfied with delighting. Like architecture, it aims at utility as well as beauty, and employs its power of delighting to instruct and guide.

The benefits which we receive from literature are comparable with those which we receive from good society. We are expected to enjoy and appreciate; we are not to be for ever asking: "What have I got that I can carry away?" Literature may be more than good society; it may compare with the intimate talk on grave subjects of a wise and high-minded friend. Unfortunately those whose office it is to introduce us to literature often treat it as if it were only a particular sort of useful knowledge. They occupy our attention so completely with grammar, metre, etymology, and historical allusions that we have no leisure to enjoy and appreciate. Dr. Bain[1] tells us that we need to be indoctrinated in points of style before we begin to read on our own account, and discourages the reading of entire plays of Shakespeare because we come across long passages which yield no marked examples of either grammar or rhetoric.

I have little fear that the scientific age which is now upon us will be permanently hurtful to literature. No new Lucretius, it may be, will write on the Universe, no new Milton on the Creation and the Fall. But contemplative and lyrical poetry will survive all changes in our philosophy. The higher criticism, which is the study of life as well as of letters, will survive too. One literary art, the art of rhetoric, may be weakened and lost when the scientific spirit becomes predominant—that sort of rhetoric, I mean, which may be fitly described as insincere eloquence. Rhetoric seeks above all to persuade, and in a completely scientific age men will only allow themselves to be persuaded by force of reason. Even in our imperfectly scientific age those men gain most by speech who have something important to say, who say no more than they know, and who use all possible plainness.

It will be enough for my present purpose if we can agree that literature has an aim and purpose of its own, and must not be treated simply as a branch of useful knowledge. Literature and science, for instance, are incommensurable.

The Necessity of Choosing.

It is an intellectual luxury to run over the kinds of useful knowledge that we should like to possess. Among them come languages, ancient and modern, some giving access to high literature, some yielding historical or scientific information, some acquainting us with communities or modes of thought very unlike our own. Then come a multitude of sciences, which perhaps show the engineer how to build railway bridges, or tell the navigator how to cross the Atlantic, or help us to improve our health and lengthen our lives. I barely mention history, geography, and innumerable practical arts. We seem to be led into a well-filled treasury, and invited to say what we will have. But one unpleasant condition is laid down; we may choose what we please, but we must pay for it. A new study generally means outlay of money, and always means outlay of time. We soon find ourselves forced to behave like the man whose wife has tempted him into a fine London shop; like him, we begin to ask: "How much can I afford to spend here?"

Every headmaster and headmistress is occupied with the eternal question how to make room for all the things that are demanded of the school. Theorisers, who have no responsibility for the time-table, insist from time to time upon new additions, and are happy if they can only express their own opinions with an emphasis which satisfies their sense of justice. It is my opinion that far too much has already been conceded to demands which, reasonable when taken separately, are unreasonable when taken together. I have known the time-table of a girls' school overloaded to such a point that in one form chemistry and English literature got no more than an hour a week between them. The headmistress no doubt hated the arrangement, but had to conform.

I have said that the grounds for introducing each separate subject are often perfectly reasonable. Thus by ancient usage Latin is made a necessary subject in certain schools. Then a claim is put in for Greek as more interesting and equally important. French and German demand admission, and put forward claims which can hardly be overstated. The result is that some boys in secondary schools attempt four languages, and many attempt three. Then we usually find that no foreign language, ancient or modern, is mastered to the point at which it can be used in reading, writing, or conversation. Our wish to be fair and consistent has landed us in an absurdity. The root of the whole difficulty lies in the fact that while there are perhaps fifteen or twenty branches of knowledge eminently fit to be taught in school, no pupil can profitably undertake more than five or six at a time. The man of business who is inveigled into a shop is better able to resist importunity than the schoolmaster. He will say: "If you insist upon the drawing-room table, you must go without the chest of drawers; if you insist upon the chest of drawers, you must go without the drawing-room table." I wish that the headmaster or headmistress might find courage and strength to require that every subject admitted

[1] "On Teaching English," p. 18.

to the curriculum should come round frequently, at least for two or three years; as nearly as may be once a day, but we cannot be rigid in these matters.

The sciences taught in school may spoil one another's chances in the same way. Not a few schools are convinced that they must have chemistry and physics because of their industrial importance, hygiene because of its relation to the health of the community, physiology to make the hygiene intelligible. The schoolboy is made to buy more sciences than he can pay for, and his time is gone before he reaps any of the advantages which are so much desired.

Too Much and too Long.

One inevitable result is that the school hours, including the preparation of lessons, are nearly always too long. Another result is that the schoolboy who is willing, but not very clever, is often overworked. I have known many such cases myself, and have also known cases in which excellent results have been attained in a good deal less than the customary time. If we could consent that our pupils should remain ignorant of many useful things, if we could materially shorten the lessons of very young pupils, and if we could bring the home-lessons into much smaller compass, I believe that the education which we offer would really be more valuable.

Natural and Artificial Education.

If we had a pupil put into our hands for solitary instruction, like the Émile of Rousseau, we should find it wise to begin by studying him closely, and three things would particularly require attention—his aptitudes, his inclinations, his opportunities. The first two are self-explanatory, but the word *opportunities* may present some difficulties. It includes, of course, opportunity of learning, but the chief stress is to be laid upon opportunity of exercise in after-life. This is the opportunity which stimulates interest and rewards exertion. Moral character, intellectual character, curiosity, love of knowledge, equipment for practical life, and, so far as I can see, all considerations which ought to govern the choice of a study, come under one or other of the three requisites—aptitude, inclination, opportunity.

In school we have not so much solitary pupils as groups of pupils to consider, and this compels us to accept compromises, which are familiar to every teacher. We have often to study the wants of a school-form as well as the wants of an individual.

Some writers have given to the education which considers first of all aptitude, inclination, opportunity, the name of *Natural Education*, while that which makes its choice of studies on abstract or arbitrary grounds, with little reference to the needs of the pupil, they call *Artificial Education.*[1] We may be allowed to revive these terms for the sake of brevity. To me they seem appropriate as well as convenient in practice.

The advocates of natural education have sometimes reached absurdity by pressing the claims of one of the three requisites to the neglect of the rest. Tolstoy would make inclination supreme, even in early education. He exemplifies Quick's remark that writers on the school-course who are not schoolmasters are almost all revolutionary. Others have attended too exclusively to the opportunity of future exercise. The old grammar schools, thinking much of the future wants of the pupils who might wish to enter the Church, often added Hebrew to the compulsory Latin and Greek. Fortification was frequently taught to little boys. When the Berlin Realschule was founded (1747) it offered, among other things, instruction in the rearing of silkworms and the discrimination of ninety kinds of leather.

Nothing, I think, gives us a clearer notion of what natural education can accomplish in favourable circumstances than foreign travel, which is a form of self-education prescribed by grown-up people to themselves. Even the milder forms of compulsion are wanting here; aptitude, inclination, and opportunity are everything. The preparation, the actual journey, and the recollections yield abundance of instruction to those who use them well. For weeks before setting out the traveller will turn over maps and conversation-books, inquire about handy cameras or collecting-boxes, and study the country which he is about to visit with an eagerness which he never felt before. The journey itself, if only it be such a journey as an active mind will frame, cannot but call forth many powers, physical, intellectual, and moral, that are rarely exercised at home. The love of science, the love of languages, the love of scenery, the love of adventure, the love of society, the love of poetry, all get a new stimulus. And the journey, already profitable in anticipation and in execution, is not exhausted when we return home. Our experiences in unfamiliar countries vivify many a page of history and many a scrap of useful knowledge which would have been otherwise languidly remarked or passed by altogether. Some years ago I had occasion to read the travels in the Levant of old Belon, a French naturalist of the sixteenth century. Though I had a purpose in reading them, they made no impression, and after a few months nothing survived but some pages of dry and unprofitable notes. Then I visited the Greek Archipelago myself, and one of the things that I made a point of doing when I came back was to read Belon again. I found it an entirely new book, full of curious and valuable observations. Now I dwelt with keen interest on his account of the various nations which had made settlements in the Archipelago, on the Greek language, on the Cretan customs of wine-drinking, on the fishes and birds, and on a hundred other details which had seemed totally uninteresting before I visited the eastern end of the Mediterranean.

Let us suppose that all is done, not *by* the traveller, but *for* him, that routes are chosen, hotel-bills paid, carriages and boats hired, languages interpreted, information supplied, all without effort on his part. In a few months he will barely remember what places he has seen and what he has passed by. This may remind us that natural education is only kept alive by *doing*.

Of course the grown-up person is not like a child, and there is need of steady and impartial government, of drill, in short, if the child is to take all the pains that are indispensably necessary in school-work. All our teaching cannot be recreative. Does not this show, some of you will say, that your natural education is inadequate, and that a sterner thing, which takes little or no account of inclination, is demanded in school?

I think not. I think that inclination is a power that we ought to employ as often and as far as we can. No doubt it is inadequate; our very definition makes inclination only one of three requisites. The child at school may usefully remind us that the opportunity of future exercise in some cases becomes necessity, and will take no denial. Nevertheless, all three should be considered, and that teacher will prosper best who lets none of them drop out of sight. Do not forget, too, that inclination is the modifiable requisite; we can stimulate, and even create it; we can also fatally discourage it. It is only natural education, I still maintain, which can count upon the energetic cooperation of the child.

On the other hand, if we ignore aptitude, inclination, and opportunity—if we pour out information upon which the pupil does no work, merely because we think it ought to be good for him, then we have a dull, perhaps a sullen, mind to deal with, which neither will nor can learn to good purpose. The example for all time of artificial education is, or lately was, the setting of every boy in every grammar school to learn Latin, if not Latin and Greek.

Those who believe that natural education is at once the most formative and the most productive, that it helps to build up body and mind, that it encourages the acquisition of truly useful knowledge, should attend to one point which often escapes notice. Natural education demands leisure for the pupil. At the present moment the leisure of the pupil has been reduced to a very small amount indeed. We strive for efficiency, for good examination results, for knowledge of useful things. The negligence of the old race of schoolmasters, which winked at monstrous abuses but allowed a certain independent school-life, has been replaced by zeal and conscientiousness, which occupy every hour, and sometimes treat independent

[1] See, for example, Henry Sidgwick in "Essays on a Liberal Education" (1887).

occupations as mere idleness. Long rambles, such as were the delight of my boyhood, when we used to go miles in search of a wasp's nest, are in certain modern schools abolished by compulsory games. Some day or other (the reform will not come in my time) we shall recognise that the chief occupation of the young child should be spontaneous natural play.

That interesting book called "Public Education," now nearly a hundred years old, in which we find a description of the methods practised by Rowland Hill and his brothers at Hazelwood and Bruce Castle, is inspired by the desire to make education natural and not merely artificial; so is that older and still better book, "Edgeworth on Practical Education." There are modern English schools which give fair opportunity for natural education. I pass over some, perhaps many, out of mere ignorance; but I will name two which I happen to know—Bedales School and the Friends' School at Bootham, York, both of which have discovered how to combine natural education with efficiency.

Heuristic Methods.

Dr. Armstrong's heuristic method is well known in this section. He tells us that neither the name nor the thing is altogether new, and the same may be said of nearly every educational expedient. Promising schemes are proposed, tried perhaps on a small scale, and dropped, often for lack of enterprise on the part of the teachers, and years after someone discovers them again. Dr. Armstrong tells us[1] where he got the name, and quotes a passage from Edmund Burke, which clearly describes the method. It is now a good many years since I saw Mr. Heller give several lessons on this plan in elementary schools in London, and was then permanently convinced of the real value of the heuristic method. I only wish that we had a score of such, each worked out as carefully as Dr. Armstrong's model.

The method need not be confined to experimental science, nor to science at all. I have attempted something of the same kind in elementary biology. Why should not teachers of history carry out a little historical research with the help of an upper form? Suppose that the subject chosen was English town and country life in the sixteenth century. Harrison's Description of England, Shakespeare's plays, Walton's Lives, some of the modern books which collect the testimony of foreign visitors during the reigns of Elizabeth and James I., Spenser's View of the State of Ireland, and Hume Brown's Scotland before 1700 are, let us suppose, accessible to the class. Useful materials from these and any other sources might be arranged in a card-index. Cooperation is eminently desirable, and a little club of pupils might well make their index in common. Then the materials should be treated in literary form, every detail of literary workmanship receiving attention. I fully expect to be told that this plan has actually been tried in some school or other. The historical researches of the school may give opportunity for the use of foreign languages, for map-drawing, or for the handling of statistical information.

Mr. Greening Lamborn's "School History of Berkshire"[2] is interesting as an investigation carried out by and for the boys of an Oxford school. It will be read in a very different spirit from that with which the condensed school-history of England is received, and will no doubt suggest more work of the same kind. The share of the boys may well grow larger and larger.

The advocates of learning by inquiry and learning by doing will descend even into the nursery. What an opportunity is afforded by toys!—an opportunity that those who purchase all their children's toys throw away. Surely every little girl ought to be encouraged to make plausible dolls out of the rag-bag, every little boy to make his own menagerie, his own boats and whistles and sledges. Even the bought toy gives opportunity for inquiry. Ask any child if he has noticed that the animals of the Noah's Ark are always thicker at one end, usually the hinder end. There is a reason for this, and a curious reason, which the child may be helped to discover.

1 "The Teaching of Scientific Method, &c.," 1903, p. 235.
2 Clarendon Press, 1908.

Mastery of Something.

Let us indulge less than we do the passion of intellectual avarice, if only because avarice blinds us to the relative values of things. The old French anatomist, Méry, said of himself and his colleagues that they were like the rag-pickers of Paris, who knew every street and alley, but had no notion of what went on in the houses. The accumulation of miscellaneous knowledge of useful things, copious, inexact, inapplicable, may, like rag-picking, leave us ignorant of the world in which we live. Let us try to reach the inner life of something, great or small. The truly useful knowledge is mastery. Mastery does not come by listening while somebody explains; it is the reward of effort. Effort, again, is inspired by interest and sense of duty. Interest alone may tire too quickly; sense of duty alone may grow formal and unintelligent. Mastery comes by attending long to a particular thing—by inquiring, by looking hard at things, by handling and doing, by contriving and trying, by forming good habits of work, and especially the habit of distinguishing between the things that signify and those that do not.

It is too much to expect that mastery will often be attained in school. School is but a preparation, not I think for promiscuous learning, but for the business of life. The school will have done its part if in favourable cases it has set a pattern which will afterwards develop itself naturally and harmoniously.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AN unusually large number of chemists attended the meeting, and in consequence very many papers, some of considerable importance, were read before the section. Chief interest attached to the discussions, which were well supported and of real value; it is worthy of consideration whether it be not advisable to devote the programme almost entirely to these. On no other occasion is it possible to have what may be termed "borderland problems" discussed conjointly with representatives of other sciences.

The most novel contribution to the section was that made on behalf of Dr. Mond, describing the preparation and properties of cobalt carbonyl. The preparation of this substance has hitherto been attempted in vain, though the remarkable compounds of carbon monoxide with nickel or iron have been known since 1890. It is now obtained by acting on finely divided cobalt with carbon monoxide at 100 atmospheres pressure between 150° and 200°. It forms large orange crystals, which decompose in the air, yielding a deep violet substance.

Sir William Ramsay related in popular terms the well-known story of the discovery of argon, helium and other gases in the atmosphere. Following him, Prof. Hartley described his researches on the detection of lithium in radio-active minerals, which are of importance in connection with the assumed transmutation of copper contained in solution into lithium, neon and possibly other substances. He adduced much experimental work to show that it is impossible to corroborate Sir William Ramsay's statements that potassium is a more widely distributed element than lithium, or that lithium is an unlikely constituent of dust, glass, copper, &c.

Prof. Rutherford described experimental work showing that the amount of neon in 1/15 c.c. of air readily gives the neon spectrum, and can so be detected. He attributed Sir William Ramsay's assumed formation of neon by the action of the emanations on water to a slight leakage of air during the experiment, and claimed that when air is excluded no neon is formed. Sir William Ramsay, replying, upheld his experiments, but agreed that the formation of lithium from copper was of a less degree of certainty than the other transmutations he has observed.

Sir James Dewar communicated a paper from Dr. Kamerlingh Onnes describing the apparatus used to liquefy helium. From the study of the isothermals of helium the critical temperature was found to lie between 5° and 6° absolute, indicating that the gas must be cooled below 30° absolute before it will cool on expansion. By boiling hydrogen under reduced pressure 15° absolute were obtained, and using 200 litres of helium it was possible to continue the experiment long enough to obtain liquid helium boiling at 4°·5 absolute. A temperature of 3° was reached without any sign of solidification. Dr. Onnes hopes to reach 1°·5 absolute. Sir James Dewar pointed out the intimate connection between low-temperature research and the theory of van der Waals, and gave an account of anticipations of and experiments on the liquefaction of helium, showing how statements made in his presidential address at Belfast in 1902 had proved to be accurate.

A discussion on the nature of chemical change was opened by Prof. H. E. Armstrong, who contended that dissolution involves associative and distributive changes. Water is supposed to be a complex mixture of active and inactive molecules, the active molecules being *hydrone* (OH_2) or *hydrone-hydrol* $\left(H_2O{<}^{H}_{OH}\right)$, and the inactive molecules closed systems formed by the association of two or more simple molecules. In a solution of hydrogen chloride molecules of the type $H_2O{<}^{H}_{Cl}$ and $HCl{<}^{OH}_{H}$ exist, the latter being the more prevalent in weaker solutions. The properties of aqueous solutions were explained on this hypothesis. Sir Oliver Lodge pointed out that these hydrogen chloride molecules were not very different from the hydrated ions postulated by followers of the ionic theory. Subsequently Prof. Armstrong's theory was adversely criticised by Dr. Findlay, Dr. Donnan, and Dr. Wilsmore.

The discussion on problems of fermentation was arranged to focus as clearly as possible the present state of knowledge. Dr. Harden gave an account of the present position of the zymase theory. He showed that the fermentative activity of yeast juice is due to two substances, which may be separated by passing through a Martin dialyser at 50 atmospheres pressure. The residue contains the enzyme, the filtrate the so-called co-enzyme, and these only ferment sugar when united, either separately being inactive. Sodium phosphate causes an increase in the rate of fermentation; apparently a hexose phosphate is first formed, which breaks down to fermentable sugar and sodium phosphate. Prof. Adrian Brown discussed cellular fermentation, which is generally stated to be controlled by the rate of diffusion of the sugar fermented into the cell. Under normal conditions the enzymes are inside the cell and do not leave it, but under unhealthy conditions the enzyme probably leaves the yeast cell.

Dr. A. Slator pointed out that the conversion of glucose into alcohol and carbon dioxide is a series of reactions, and that the velocity of change is determined by the rate of the slowest reaction. The rate of fermentation is proportional to the amount of yeast present, and independent of the concentration of the sugar. He suggested that glucose and fructose are fermented by one enzyme, mannose by another, and galactose by a third. Galactose is fermented only by yeasts which have been grown in the presence of galactose.

Dr. E. F. Armstrong dealt with the *rôle* of enzymes in fermentation. The mechanism is quite distinct from the sucroclastic enzymes; in the case of glucose, fructose, or mannose the first step is the conversion, by means of an enzyme, into the common enolic form, and the formation of a compound between enzyme and enolic form. He further alluded to the question of adaptation of the organism to nutrition, pronouncing in favour of the view that something which is already present, though hitherto latent, is developed in response to stimulation, and opposed the idea that an altogether new enzyme is formed. This view was developed by Prof. Gotch and Prof. Keeble. Prof. H. E. Armstrong described the recent work of F. Ehrlich, who has shown that the supposed by-products of alcoholic fermentation are in reality produced by the action of yeast on amino-acids derived from the protein complex.

Messrs. Julian L. Baker and H. F. E. Hulton contributed a preliminary note on the action of the enzymes of malt on ungerminated cereals. A considerable increase in the diastatic activity of barley takes place when it is digested in presence of malt extract.

Prof. W. H. Perkin gave a brief account of the history of synthetical progress in the terpene series, and described the methods and stages in the process of synthesis of terpineol, carvestrene, and also the first optically active terpineol. Subsequently, Dr. Weizmann dealt with the methods suggested for the preparation of synthetical camphor on a commercial scale. Under laboratory conditions many of the processes yield from 70 per cent. to 80 per cent. of the theory, but on a large scale the yield and purity of the product have frequently left much to be desired. A method was described of converting pinene hydrochloride into *iso*bornyl acetate by means of glacial acetic acid and zinc chloride.

Dr. T. M. Lowry gave an account of the work done by the committee on dynamic isomerism. The most important feature of the year's work has been the discovery of a group of agents by means of which isomeric change—in the case of camphor derivatives—can be retarded or completely arrested. Such are carbonyl chloride and acetyl chloride; the action of the former probably depends on its power of converting ammonia and bases, such as piperidine, into neutral carbamides. The relationship between absorption spectra and isomeric change has been tested in the case of a number of optically active camphor derivatives.

A further case of dynamic isomerism observed in derivatives of oxymethylene camphor was described by Prof. W. J. Pope and Mr. John Read.

Dr. J. A. Smythe dealt with problems of tautomeric change in a paper on the reaction between benzyl sulphoxide and hydrochloric acid.

Matter of very great interest was contained in a paper by Prof. Adrian Brown on the selective permeability of certain seeds. The coverings of grains act as semi-permeable membranes towards sulphuric acid solutions; water passes into the grain, and the acid solution becomes more concentrated. The membrane prevents the passage even of 36 per cent. acid, but in this case water passes out of the grain to dilute the acid. The membrane is likewise impermeable to most salts. Iodine, however, does pass through, also mercuric chloride and cyanide, but no other mercury salts. Organic acids, such as acetic acid, pass through the membrane, but not lactic acid. The grains thus exercise selective permeability, the permeable compounds being non-dissociated or only very slightly dissociated.

A report on colloidal chemistry was presented by Prof. Procter, and approved for printing *in extenso*. This deals very fully with the properties of colloids and with the history of the more recent development of the subject, the industrial importance of which is being gradually recognised. Not only are tanning and dyeing particularly concerned with the mutual precipitation of colloids, but such industries as rubber, gums, dextrin, glue, and cellulose are all colloidal, as also many inorganic industries, *e.g.* glass manufacture and pigment making. Such a summary is very opportune at the present moment.

Dr. A. Findlay gave a preliminary account of an investigation of the influence of colloids on the absorption of gases by water, a subject which has a bearing on the absorption of carbon dioxide by blood. Most of the colloids studied had relatively little influence on the solubility of carbon dioxide in water.

Prof. Pope and Mr. Wm. Barlow gave a short account of their theory of valency as applied to elucidating the structure of the open-chain hydrocarbons. This was illustrated by some excellent models. The subject of valency was further dealt with from a theoretical point of view by Mr. H. Bateman, who defines valency as a number which indicates the degrees of freedom for departure from the existing state of motion of the charged particles which constitute the element.

Dr. J. Timmermans showed an apparatus and described investigations on the densities of liquids from 0° C. to their melting points in continuation of Young's experiments on the rectilinear diameter.

Dr. H. J. S. Sand gave a demonstration on the rapid electro-analytical separation of metals with the apparatus described in the Journal of the Chemical Society. A somewhat similar apparatus was briefly described by Dr. F. M. Perkin.

Interesting results obtained with transparent silver and other thin metallic films were shown by Prof. T. Turner. Thin gold leaf becomes transparent when heated to about 550°; the change does not depend on the nature of the atmosphere. Thin silver leaf requires the presence of air or oxygen for a similar change. Thin sheet copper, heated to 200°, becomes transparent, and transmits yellow-green light quite freely.

A discussion on the practical utilisation of peat was opened by a paper from Dr. Woltereck, dealing with the production of ammonia from atmospheric nitrogen by means of peat. Experiments have shown that a mixture of nitrogen and hydrogen passed over reduced iron at a low heat produces ammonia, and that the presence of oxygen and water was of importance. Finally, the hydrogen was omitted and peat substituted for the iron with satisfactory results. It is claimed that atmospheric nitrogen cooperates in the formation of ammonia. Subsequent speakers included Prof. Ryan, Prof. Turner, Sir James Dewar, and Mr. K. B. Eller, but the discussion failed to bring out any new facts of importance.

The aromatic nitroamine committee (secretary, Dr. K. J. P. Orton) reported on the transformation of nitroamino-benzenes into nitro-anilines. The influence of the solvent, nature of the acid catalyst, and the effect of concentration of the acid and temperature have been studied.

The report of the committee for the study of hydro-aromatic substances (secretary, Prof. A. W. Crossley) contained the usual valuable summary of recent work in this field, together with new investigations on dimethyldihydrobenzene.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE geologists who were privileged to attend the meetings of Section C at Dublin will always recall with pleasure the kindly welcome and helpful assistance extended to them by the home geologists. Not only did they give us a president whose brilliant address promises to be historic, and arrange for our benefit a delightful series of excursions in the neighbourhood of Dublin, but they communicated many papers of great interest, and took a very active part in the work of the section.

Prof. Cole's lecture on the geology of the country round Dublin, which followed the president's address, summarised the principal points of interest in the district, and led us to a clearer view of the many important features we were enabled to see in the afternoon excursions organised and led by Mr. H. J. Seymour and others.

Prof. Cole also contributed two other papers, one dealing with the examination of the stones brought up during the dredging expeditions of the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland. The discovery, off the coast of Kerry, of abundant flints, chalk, glauconitic chalk, and Milioline limestone showed that the Cretaceous and Eocene seas extended to an unknown distance towards the west.

The other paper was explanatory of an exhibit of the types of rock formed during the intervals between the basaltic eruptions in the north of Ireland in Eocene times. It was urged that the red lateritic zone represents basalt altered *in situ*, and is clearly connected with the climatic conditions of Eocene times. The pale bauxites are considered to be derived from sporadic eruptions of rhyolite, and a thin bauxite layer overlying the pisolitic iron-ore may in part be formed by wind-borne material.

Messrs. R. J. Ussher, H. J. Seymour, E. T. Newton, and R. F. Scharff gave the results of their joint work in the exploration of the Cave of Castlepook, near Doneraile. Both the geological evidence and the characteristics of the fauna collected lead towards the conclusion that the cave is pre-Glacial in age, and support the opinion that Ireland has not been joined to England by land in Glacial or post-Glacial times.

Messrs. H. B. Muff and R. Carruthers described the structure of the Leenane district, co. Galway, and Prof. S. H. Reynolds and Mr. C. I. Gardiner dealt with rocks along the same strike in the Tourmakeady district, co. Mayo.

The veteran geologist Mr. G. H. Kinahan, although prevented from attending the meeting through illness, sent a paper on the raised beaches of the Liffey Valley, and Mr. H. Bolton reported the details of a boring in the Lower Coal-measures at the Emerald Pit, Dungannon.

The igneous rocks of the seldom visited outer Blasket Islands were described by the president.

Besides the above papers dealing with Irish geology, a fine collection of photographs of geological interest, and a typical set of Irish rocks, were exhibited by Mr. R. Welch and other local workers.

Desert phenomena, which have played so important a part in the proceedings of the section for some years past, were again discussed in several important papers. Dr. W. F. Hume contributed notes on the petrography of Egypt, Mr. G. W. Grabham dealt with the well-water supply of the north-east Sudan, Dr. A. Hutchinson gave the results of a chemical and physical examination of some remarkable crystals of dolomite obtained from Algeria, while fossil deserts were referred to in the report of the Trias Committee. With the view of obtaining further data regarding the conditions under which the Triassic rocks of Britain were laid down, a new research committee was appointed to conduct investigations in the marginal parts of the Sahara about Biskra, in Algeria, and Mr. J. Lomas will shortly proceed to Africa to make observations bearing on the point.

In glacial geology two papers were presented. Dr. Dwerryhouse, in reading the report of the Erratic Blocks Committee, showed that there is still much useful work to be done, despite the long time the committee has been at work. Prof. W. M. Davis, of Harvard University, in dealing with the glacial erosion in north Wales, confined his remarks to the Snowdonian district. He demonstrated that in Tertiary time the mountains existed as a group of monadnocks surmounting a peneplain which extended far into mid-Wales. During the Glacial epoch the intervening valleys were deepened, and cwms were formed which showed that glacial erosion in certain valleys amounted to 400, 600, or 800 feet.

In mineralogy and petrography eight important papers were read. The president, in the course of an examination of the Deccan basalt, found them to contain native iron and gold. Dr. A. Hutchinson described a new method of drawing stereographic projections of crystals, and exhibited a protractor designed for the use of students of crystallography. Dr. H. A. Bemrose showed and described a number of slides illustrating the microstructure of Derbyshire limestones, and Mr. H. Brodrick contributed a note on the structure and occurrence of cave pearls. Dr. Tempest Anderson's paper on the changes in the Soufrière of St. Vincent was a continuation of the work done by Dr. Flett and himself on the remarkable volcanic eruptions which occurred in the West Indies a few years ago.

Dr. J. Milne, in discoursing on the duration and direction of large earthquakes, showed that while small earthquakes have a duration of a few seconds near their origin, and at a distance of fifty to 100 miles they may not be recordable, large earthquakes suffer no appreciable decay during transmission, and their duration appears to increase rather than decrease. Another observation in connection with recent seismological observations is that large earthquakes travel farthest in particular directions.

Other papers on earth movements were contributed by Prof. W. H. Hobbs and Dr. Woolacott. The former dealt with the recent earth movements within the basin of the Laurentian lakes, and by methods of precise levelling he was able to demonstrate that the recent tilting of the province proceeded at variable rates at different points.

Dr. Woolacott, in describing a case of thrust and crush brecciation in the magnesian limestone of Durham, showed that the beds have been thrust against a horst, the flexible beds have been deformed without being much broken, while the harder, brittle limestone has been highly brecciated. He estimates that the amount of lateral displacement has been about 100 yards, and by experimental tests he indicates the magnitude of the thrust to have been about 300 tons per square foot.

The president, in opening a discussion on mountain building, referred to recent investigations on mountain structure, which revealed the fact that in the overlap of recumbent folds the uppermost folds were of greater span than those beneath, and this could not be explained on the notion that horsts of the accepted type were responsible for the features observed. He calculated that at the depth at which the horsts were supposed to exist the rocks would be in a viscous condition owing to radio-active heating and incapable of transmitting a direct thrust. With rigid rocks overlying a viscous mass he showed that compressive forces would cause the rocks to bulge upwards, and lying folds would be produced. Sir Archibald Geikie described the two-fold types of mountains, one possessing the Alpine structure and the other taking the form of plateaux upraised without disturbance except at their margins. He could not accept the explanation offered by Suess for the latter type, that the sea had fallen. He reminded the audience that folding was not all of one age, and the forces which have produced the Alps in the past may be acting at the present day.

Prof. Lapworth, in describing the principal mountain ranges on the earth's surface, urged that in their distribution they follow the curves of harmonic motion. Those existing beneath the ocean or as festoons of islands fall in with the general scheme as illustrated by the law of curves. All the islands of the world and all the mountains are strung on a great circle which corresponds with the line dividing the land and water hemispheres. The northern and eastern hemispheres are above the node of the great curve, while the southern and western hemispheres are below the node. On the great master folds there are smaller corrugations bearing the same relations as the harmonics to the fundamental in a vibrating cord. In this way the central depressions of continents can be correlated with the submerged ridges in the ocean depths.

Prof. Sollas, in referring to the theory put forward by the president, showed that piled-up folds would blanket the deep-seated rocks, and a highly heated region beneath mountain folds might account for the lower value of gravity observed in the neighbourhood of mountain chains. The approximation of remote areas brought about by folding involved the transference of viscous material from one region to another. This would not only result in bulging up, but in the lateral traverse of material. The thrusting which built up the Alps and the Carpathians was felt in the British Islands, and the cracks produced in the splintered crust of Scotland and the north of England might have afforded a passage for the underlying lava, which perhaps originated under the Alps. Given the deformational figure of the earth, the position of mountain chains follows from it, since on Prof. Joly's theory they will arise where sedimentation has taken place, *i.e.* at the limit of land and water.

Prof. Cole suggested that the older opinion of Scrope regarding uplift and sliding was receiving confirmation in later days, and the festoon arrangement of islands and mountain chains was the result of the frontal movements of sliding masses.

Palæontology was represented in the section by papers dealing mainly with the fossil Reptilia. Prof. H. G. Seeley described a fossil reptile from the Upper Karroo of Cape Colony which possessed a proboscis or trunk, and in a second paper the dentitions of the Cynodontia and Gomphodontia were contrasted.

The occurrence of reptilian footprints in the Inferior Oolite of Whitby was announced by Mr. H. Brodrick, and in the Trias report Mr. H. C. Beasley described the tracks of invertebrates found in association with footprints in the Triassic rocks.

Mr. W. Whitaker, in describing a deep boring recently made on the Thames marshes at Cliffe, reported a fact which has an important bearing on the character of the floor of older rocks underlying the Secondary rocks of Kent. At 1030 feet below Ordnance Datum Silurian rocks were penetrated. The practical bearing of the boring is that it puts a northern limit to the Kent coalfield.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE large number of individual papers presented this year made it necessary to hold afternoon sessions each day of the meeting, and even then it was difficult to find room for all the papers. Apart from the president's address, which has been published already (October 1, p. 553), the various communications are described herein, but owing to lack of space some of the papers, which cannot be conveniently summarised, are noted only by title.

After the presidential address, Prof. Sherrington, F.R.S., read a paper on proprioceptive reflexes of the limb. In a decerebrate animal the two hind legs are prepared so that all the muscles, except the extensor of each knee, are paralysed. Thus there is left on each side an afferent and an efferent nerve supply from a single muscle. The limbs are supported so that the knee can be extended by muscular contraction and flexed by gravity. Flexion at the right knee causes extension of the left leg, whilst extension on the right causes flexion on the left; that is, stretching the extensors causes a reflex contraction of the crossed extensors, and relaxation of the extensors produces reflex inhibition of the crossed extensors. The tone of the muscle depends on reflex impulses from itself, and when the extensor is passively stretched it does not return to its original length, but, being inhibited, remains more flexed than it had been; conversely, relaxation of the extensors leaves the limb in a more extended position. The final report of the committee on the "metabolic balance sheet" of the individual tissues was presented by Prof. Gotch, F.R.S. The object of the committee, namely, the development of sound and fruitful methods for investigating the metabolism of individual tissues, having been accomplished, it did not desire re-appointment. The report reviews the work that has been done by the committee during the past five years. The technique of various experimental procedures has been improved upon, and these improvements are dealt with as follows:—gas analysis, anæsthetics, prevention of clotting, measurement of rate of flow, and analysis of gases of perfusion fluids. The organs employed and a comparison of the results obtained are stated, and the report concludes with a list of the papers so far published as a result of the work of the committee. Sir Lauder Brunton, F.R.S., whilst presenting the report of the committee on the effect of climate on health and disease, read a paper on influenza, showing that epidemics of influenza are accompanied by an increased death-rate from pulmonary diseases, and he compared these outbreaks with various meteorological data. Dr. Grabham then gave a paper on the physics of high altitudes in relation to climate and health. From various measurements of humidity, wind pressure, and electrical potential he suggests that deficient electrical charge in the atmosphere is one of the conditions in a relaxing climate.

In the afternoon Prof. Swale Vincent presented the report of the committee on ductless glands. The view that the thyroid and parathyroids are intimately related is supported, and evidence is furnished that the suprarenal gland constantly pours its secretion into the blood stream, and thus regulates the blood pressure. Prof. Macallum, F.R.S., read two papers. In the first he recorded the analysis of urine in polyuria produced by the ingestion of large quantities of water. The total solids were so reduced that freezing-point determinations showed a very much reduced lowering. The percentage of chlorides decreased from the onset of polyuria, whilst that of potassium did not diminish until later on; thus at first the potassium showed a marked rise relatively to the sodium; at the same time, he could not find any appreciable dilution of the blood. These experiments are contrary to the view that urine is merely filtered from the blood, but they suggest that there is a selective action of the epithelial cells. His second paper dealt with the distribution of potassium salts in the cell, and he ascribed their localised situation to surface-tension effects. Prof. MacDonald considered that these local appearances were explained by these points being stimulated portions of the protoplasm. Dr. Hewitt read a paper advocating improvement in the training of anæsthesists. He pointed out that the number of deaths from anæsthesia is increasing, and recommended that all medical students should be taught, by a qualified instructor, the best method of administering anæsthetics. Prof. Waller, F.R.S., demonstrated tracings obtained from muscles immersed in saline containing varying percentages of chloroform, ether, or alcohol. The relative toxicity of these drugs is that 1 molecule of chloroform = 12 molecules of ether = 100 molecules of alcohol.

On the Friday morning the first item was a discussion on mental and muscular fatigue, introduced by Dr. W. McDougall. He stated that fatigue is the change in ratio of two variable factors, one of which is the amount of available energy and the other the resistance which has to be overcome. As the resistance rises it is more difficult to do work until a point is reached where fatigue is manifested. This fatigue can be overcome by some more stimulating occupation, but in the end the subject is left more fatigued. He also discussed the effect of waste products and the removal of reserve food material on the activity of the cells. The resistance, which he supposed to take place at the synapse, is protective, as it prevents too great a drain of energy by continued action. Rise of resistance in one path diverts the impulse into another path, and this is exemplified by the difficulty of maintaining the attention on any one detail, as fatigue is delayed by minute variations in the object of attention. He then illustrated various nervous disorders as depending on the ratio of resistance to energy. Prof. MacDonald treated the subject of muscular fatigue, pointing out the change in distribution of salts and water during muscular contraction. Potassium salts are liberated in the central portion of the sarcomeres, thus causing a rise in osmotic pressure, and this attracts water from the neighbouring portions of the muscle fibre, causing this portion of the sarcomere to swell laterally. The contraction is the result of the shortening due to transference of water from the longitudinal to the transverse axis of the muscle. Prof. Milroy spoke about fatigue of colour sensations in simultaneous contrast. Mr. Sackville Lawson gave some measurements of skin sensation by the æsthesiometer, showing that mental fatigue diminishes the acuity of touch sensations. Several others took part in the discussion. Prof. Elliot Smith, F.R.S., then gave two communications. The first, in conjunction with Prof. Wilson, described the results of electrical stimulation of the cerebral cortex of certain lemurs. The second presented a map of the brain showing different areas which correspond to different naked-eye appearances of sections made transversely to the cortex.

During the afternoon session the following papers were read:—Prof. Gotch, F.R.S., showed tracings of photo-electric changes in the eye on exposure to light. The fundamental change is a prolonged electric current due to changes in the visual purple, because this current does not appear after the visual purple has been bleached. At the moments of exposure and cutting off of light there are more intense currents which are only of short duration, but they occur even after bleaching of the visual purple. These two rises are mounted on the more prolonged rise due to the visual purple. Repeated illumination causes the appearance of a precursor to the sudden rise due to illumination, and this precursor is a current in the reverse direction to the other currents. All colours of light can bleach the visual purple. Dr. Edridge-Green described methods for testing colour-blindness, and demonstrated apparatus for performing the various tests. Prof. Waller, F.R.S., presented the report of the committee on the electrical phenomena and metabolism of arum spadices. Dr. MacLean described experiments showing that all the nitrogen in lecithin is not present as choline, and Sir James Grant read a paper on the gastro-intestinal ganglionic nervous system.

Monday morning was commenced by a discussion on instruction of school teachers in physiology and hygiene, introduced by Prof. Sherrington, F.R.S. He pointed out that school teachers, having the charge of so many children, should know how to take care of their health and be able to detect certain departures from the normal. Physiology is the basis of hygiene, and if physiology is known hygiene follows as a practical and common-sense application of its laws. Psychology is also important, as it gives the teacher an insight into the minds of his pupils; but here again physiology should be known first. The subject should not be taught by books alone, but by demonstrations and practical work, as that is the only way really to appreciate any science. Prof. Thompson detailed the steps that had been taken to teach physiology to school teachers in Ireland. Prof. Gotch, F.R.S., said that the teacher should learn physiology to apply it, but not to teach it. Any instruction to the children should be by example and not by precept. Dr. McVittie gave instances of the effect of neglect of hygiene in schools. Other speakers emphasised the importance of teaching physiology to school teachers in order that the general public might have a more enlightened view of hygiene, especially personal hygiene. Prof. Sherrington then presented the report on the conditions of health essential to the carrying on of the work of instruction in schools (prepared for Section L). After the closing of the discussion Prof. A. Kossel (Heidelberg) read a paper on amyloid, identifying the various radicals which enter into its constitution. Dr. Cathcart described experiments showing that various substances introduced into the pyloric portion of the stomach cause secretion in the fundus. Tap-water, although causing energetic movements of the pyloric segment, was about the only substance which did not cause secretion. It was not definitely determined whether the secretion is due to chemical or nervous stimulation. Dr. Ellison showed records illustrating the effect of intravenous injection of a substance isolated from commercial peptone. Dr. Dawson Turner read a paper on the hæmorenal index, and demonstrated growth by osmosis after the method of Prof. Leduc.

At the afternoon meeting Dr. Copeman, F.R.S., presented the report of the committee on body metabolism in cancer. Dr. Page May gave lantern demonstrations showing (*a*) a hitherto undescribed (postero-septal) tract in the spinal cord, and (*b*) cells and tracts concerned in paralysis and recovery from paralysis. Mr. Walker read a paper describing the effect of two antisera prepared in rats by injecting in one case extract of testes and in the other carcinoma cells from an experimental tumour. These antisera, injected into mice infected with the same strain of experimental tumour used in preparing the second antiserum, appeared to interfere with the development of the growth. Prof. McWeeney described the technique used by him in carrying out the biological method of identifying blood stains, and he also testified to its value from a medico-legal standpoint. Prof. B. Moore read a paper, for himself and Dr. Roaf, on the action of acid and alkali on the growth and division of animal and vegetable cells. The sitting was terminated by a lantern demonstration, by Dr. Herring, of the changes in the pituitary after thyroidectomy. Removal of the thyroid causes a colloid-like substance to be formed in the pituitary, and this substance passes through into the third ventrice, thus reaching the cerebro-spinal fluid.

On Tuesday morning a joint meeting with Section D was held. Most of the papers are noted under the proceedings of that section, but the two following papers are of physiological interest. Dr. Nierenstein described experiments showing that atoxyl combines with proteins, but the diacetyl compound does not. *In vivo* the acetyl compound is hydrolysed, and acts like atoxyl. He compared the pharmacological action to the chemical process of dyeing, where the chromophore is represented by the arsenic and the chromogen by the amido-group in atoxyl, and the mordant is replaced by protein. Prof. B. Moore described the effect of many substances upon experimental trypanosomiasis. The combined treatment, using atoxyl followed by mercury, is the best, and the only other metal that can compare in action with arsenic is antimony.

The section closed by a meeting on Tuesday afternoon, with Lord Aberdeen in the chair. Sir Robert Matheson read a paper on the anti-tuberculosis campaign in Ireland.

H. E. ROAF.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At Emmanuel College, the exhibition of 50*l*., tenable for two years, offered to an advanced student commencing residence this October, has been awarded to L. J. Russell, Glasgow University. Other exhibitions of 30*l*., tenable for two years, have been awarded to W. T. Gordon, Edinburgh University, and to A. Ll. Hughes, Liverpool University.

OXFORD.—The jubilee of the inception of the University museum is to be commemorated to-day, October 8, by a meeting in the Sheldonian Theatre and a conversazione at the museum. A distinguished company has accepted invitations to be present. The foundation-stone of the building was laid on June 20, 1855, and the work was completed in October, 1858. Its erection represents the result of a movement for the provision of "an edifice within the precincts of the University for the better display of material illustrative of the facts and laws of the natural world." One of the aims of the promoters of the scheme was to gather together various branches of sciences "for mutual aid, and easy interchange of reference and comparison." The museum has thus connected with it departments of medicine and public health, comparative anatomy, physiology, human anatomy, zoology, experimental philosophy, physics, chemistry, geology, mineralogy, ethnography, and pathology. Teaching began in two departments fifty years ago, and the present museum represents the outcome of that beginning.

In connection with the celebration of the jubilee honorary degrees are to be conferred upon Prof. Arrhenius and Dr. A. G. Vernon Harcourt, F.R.S. At the reception in the afternoon Dr. Harcourt will give a short account of the establishment and work of the museum, and a bust of Prof. W. F. R. Weldon, who died in 1906, will be unveiled.

MR. JACOB SASSOON has given ten lakhs of rupees (66,000*l*.) to establish a central college of science in Bombay.

THE Salters' Company has voted 100*l*. per annum for a period of three years to the cancer research laboratories of the Middlesex Hospital as a research scholarship.

THE distribution of prizes, diplomas, &c., at the South-Eastern Agricultural College, Wye, will be made on October 21, when Sir Horace Plunkett, F.R.S., will deliver the inaugural address.

THE Pereira medal of the Pharmaceutical Society, awarded annually for high proficiency in *materia medica*, botany, and chemistry, was presented to Miss Gertrude H. Wren on September 30, this being the first occasion upon which the prize was received by a woman.

THE Child Study Society of London will resume its meetings for lectures and discussions on October 15, at 8 p.m., in the Parkes Museum, Margaret Street, London, W. At the opening meeting Dr. C. W. Kimmins will deliver an address on the relation of the curriculum to the development of the child. At subsequent meetings Miss Alice Ravenhill will describe some results of an investigation into hours of sleep among English elementary-school children; Dr. G. Eric Pritchard will lecture on the physiology of the child; Dr. F. H. Hayward will deal with education and recent studies in heredity; and Dr. James Kerr will take for his subject the educational revolution and some hints for the future.

THE Board of Education has issued the following list of successful candidates for Royal exhibitions, national scholarships, and free studentships (science), 1908:—*Royal Exhibitions:* A. Riddle, Portsmouth; T. J. Hornblower, Southsea; A. H. Gabb, Swindon; A. E. Stone, Portsmouth; F. Morris, Portsmouth; S. B. Hamilton, Halifax; A. H. Barrett, Southsea. *National Scholarships for Mechanics (Group A):* B. C. Carter, Southsea; A. J. White, Southsea; H. H. German, Devonport; W. F. Boryer, Portsmouth; H. Mawson, Hunslet, Leeds. *Free Studentships for Mechanics (Group A):* G. W. Bird, Plymouth; H. G. Stephens, Leicester. *National Scholarships for Physics (Group B):* J. Lamb, Gateshead; H. Billett, Swindon; F. C. Hobbs, Bristol; R. Ecker, Norwich; T. W. Johnstone, Neyland, Pembrokeshire. *Free Studentships for Physics (Group B):* P. H. S. Kempton, Swindon; W. Jevons, Smethwick. *National Scholarships for Chemistry (Group C):* W. A. C. Newman, Leeds; E. W. Yeoman, Southampton; F. Hargreaves, Burnley; L. D. Goldsmith, London; E. Jobling, Hull; E. O. Jones, Leeds. *Free Studentship for Chemistry (Group C):* L. Owen, Trefriw, Carnarvonshire. *National Scholarships for Biology (Group D):* E. Hill, Bradford; H. Wormald, Wakefield; T. E. Herbert, London. *Free Studentship for Biology (Group D):* E. T. Halnan, London. *National Scholarships for Geology (Group E):* H. Hart, Camborne; A. Sharples, Burnley; J. W. Chaloner, Burnley.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, Received July 31.—"On Helium in Saline Minerals, and its Probable Connection with Potassium." By the Hon. R. J. **Strutt**, F.R.S.

In a former paper (Roy. Soc. Proc., A, vol. lxxx., p. 592) the author mentioned that saline minerals were often comparatively free from contamination with radio-active material of the uranium-radium series. Accordingly, they afford special opportunities of testing whether or not helium is generated by the other elements present, namely, sodium, potassium, magnesium, calcium, sulphur, chlorine, oxygen, hydrogen. In this paper determinations are given of helium and radium in some of the saline minerals of Stassfurt.

Helium was liberated by solution of the mineral in water, and was suitably purified. Uranium was determined in the same solution, by the usual method of boiling out the radium emanation generated in a definite period.

The results were as follows:—

Mineral	Composition	Helium, c.mm. per 100 grs.	Grams uranium oxide (U_3O_8) per 100 grs.	Helium, c.c. per gr. U_3O_8
Rock salt .	$NaCl$	0·0233	$7\ 1 \times 10^{-6}$	3·3
Sylvine . .	KCl	0·55	$2·15 \times 10^{-6}$	256
Carnallite .	$KMgCl_3 6H_2O$	0·151	$3·23 \times 10^{-6}$	47
Kieserite .	$MgSO_4 H_2O$	0·0179	$6·47 \times 10^{-5}$	0·277

Some other salts were also examined qualitatively.

In none of them was the quantity of helium at all comparable with what was observed in carnallite or sylvine, though D_3 could generally be seen.

Returning to the quantitative experiments, it is noticeable that very high ratios of helium to uranium oxide are met with in these two minerals.

It seems altogether improbable that the minute traces of uranium and radium present can account for so much helium. On the other hand, the helium in rock salt is very much of the order to be expected from its geological age if it originates from the uranium family of radio-active bodies.

In view of Campbell and Wood's observations on the radio-activity of potassium (Camb. Phil. Soc. Proc., vol. xix., p. 15), the author is disposed to regard that element as the source.

Received July 28.—"On the Accumulation of Helium in Geological Time." By the Hon. R. J. **Strutt**, F.R.S.

In a former paper (Roy. Soc. Proc., A, vol. lxxx., 1908, p. 572) the author gave an account of experiments on the presence of helium in a variety of the common minerals of the earth's crust. The conclusion arrived at was that the quantity of helium is, in general, determined by the traces of radio-active elements present. The minerals investigated were mostly of Palæozoic age, and little attention was paid to the effect of geological age on helium content. If, however, the accepted theory of the progressive accumulation of helium in minerals by radio-active change is correct, it is evident that geological age must be all-important. In the present paper the subject is considered from that point of view.

There is some difficulty in finding suitable material for comparing the helium content of minerals with their geological age. The author has been fortunate in discovering that phosphatic nodules (the so-called coprolites) and phosphatised bones are extremely rich in radio-active constituents, sometimes containing fifty times as much radium as the generality of rocks. These nodules and bones are found in a great variety of strata, from the Pliocene downwards. The nodules frequently contain, or consist of, fossils characteristic of the stratum to which they belong, or of one very little earlier; thus their age is well defined. The same remark applies still more to the mineralised bones. There is no reason to doubt that the radio-active material was introduced into the bones by infiltration at the time that they became phosphatised, and from that epoch the accumulation of helium must be dated.

In these experiments the author has extracted the helium by solution of the powdered substance in hydrochloric acid. The action takes place quite readily.

Radium was determined by the methods described in earlier papers. The solution obtained in extracting helium was usually employed for the radium determination.

The uranium oxide percentage was calculated from the radium observations by standardisation with a uranium mineral.

The results may be tabulated as follows:—

Material	Locality	Geological Horizon	Helium, c.mm. per 100 grams	U_3O_8, grams per 100 grams	Helium, c.c. per gram of U_3O_8
Phosphatised shark's teeth ...	Florida	Pliocene	0·174	$2·48 \times 10^{-2}$	0·0070
Phosphatised Cetacean bones ...	Felixstowe	Pliocene Red Crag	0·158	$1·55 \times 10^{-2}$	0·0102
Phosphatic nodules	,, ...	,, ,, ,, ...	0·098	$4·78 \times 10^{-3}$	0·0205
,, ,, ...	Cambridge	Upper Greensand	3·03	$1·08 \times 10^{-2}$	0·281
,, ,, ...	Potton, Bedfordshire ...	Lower Greensand	2·10	$5·83 \times 10^{-3}$	0·360
Phosphatised Saurian bones ...	Ely	Kimmeridge Clay	<0·365	$3·28 \times 10^{-3}$	<0·111
Phosphatic nodules	Knapwell, Cambs.	Base of Kimmeridge Clay .	<0·675	$7·20 \times 10^{-3}$	<0·094
Phosphatised Saurian bones ...	Whittlesea	Oxford Clay	<0·51	$9·15 \times 10^{-4}$	<0·558
Phosphatic bone fragments ...	Lyme Regis	Rhætic bone bed	<0·22	$2·15 \times 10^{-3}$	<0·102
Hæmatite	Frizington, by Carnforth, Cumberland	Above Carboniferous Limestone	16·5	$1·28 \times 10^{-3}$	12·9
Phosphatic nodules	Near Bala	Bala beds	15·3	$3·23 \times 10^{-3}$	4·74
Phosphatic limestone	Chirbury, Shropshire ...	Llandeilo Limestone... ...	5·6	$7·90 \times 10^{-4}$	7·10
Phosphatic nodules	Cailleach Head, Loch Broom	Torridon Sandstone	0·83	$9\,9 \times 10^{-4}$	0·84

It will be at once noticed that the order of stratigraphical position is not accurately followed. For example, the phosphatic nodules and bones from the Kimmeridge Clay do not show so high a helium ratio as those from the Lower or Upper Greensand, though they are geologically older than either. At the same time it will be noticed that helium ratios approaching 12, such as are common in the mineral veins of Carboniferous age in Cornwall, are not met with in the younger strata.[1] The facts are most easily explained by supposing that the retention of helium has been often, if not always, imperfect.

One point remains to be referred to. If thorium were present in any of these materials we might expect it to have a disturbing influence, as an independent source of helium. The most searching experiments the author has been able to make have only suggested a faint suspicion of its presence in the phosphatic nodules and bones. It can contribute nothing appreciable to their activity. The same applies to Cumberland hæmatite; in this case the results were still more distinctly negative.

The chief interest of the present results is in their application to the measurement of geological time. For this application we require to know the rate at which helium is produced from 1 gram of uranium with the equilibrium quantity of all the other products of the series.

Prof. Rutherford has kindly communicated to the author his latest estimate. It is that 316 cubic mm. of helium are produced per gram of radium per annum. This is deduced on the following assumptions:—

(1) The number of helium atoms produced is equal to the number of α particles emitted.

(2) For every four α particles emitted by radium with its immediate products, two are emitted by uranium, one by ionium, and one by polonium.

The author does not enter on any discussion of the validity of these suppositions, beyond remarking that there are no definite grounds at present for deciding whether or not helium is liberated in the rayless changes.

Taking the ratio of radium to uranium in minerals as $3·4 \times 10^{-7}$, we get for the annual helium production per gram of uranium oxide, (U_3O_8) in a mineral, $9·13 \times 10^{-8}$ c.c.

Adopting this rate of growth provisionally, the following ages are obtained *as a minimum* for some of the materials examined:—

	Years
Phosphatic nodules of the Crag	225,000
Phosphatic nodules of the Upper Greensand...	3,080,000
Phosphatic nodules of the Lower Greensand...	3,950,000
Hæmatite overlying Carboniferous Limestone	141,000,000

It must be emphasised that these absolute values are provisional only. It is hoped that geologists and others will not regard the method as discredited if it should be necessary to alter them considerably, when the rate of growth of helium has been directly determined.

The conclusions of this paper may be summarised as follows:—

(1) Phosphatic nodules and phosphatised bones of all geological ages possess marked radio-activity, many times higher than that of rocks. This activity is due to products of the uranium series.

(2) Helium has been detected in these materials, even when they are not of more than Pliocene age.

(3) The ratio of helium to uranium oxide has been measured. This ratio does not strictly follow the order of superposition of the strata; but high ratios are not met with in the younger deposits, whereas they are common in the older ones. It is conjectured that helium has been imperfectly retained, at all events in some cases.

(4) Provisional values are given for the time required to accumulate the quantity of helium now found in the nodules and other materials.

PARIS.

Academy of Sciences, September 28.—M. Bouchard in the chair.—Two applications of Fredholm's equation to some problems of mathematical physics: Emile **Picard**. When a problem has been reduced to this equation it is usually sufficient to examine whether this is a singular case or not. In certain circumstances more complex conditions may arise; two simple examples of such cases are discussed in the present paper.—Experimental parthenogenesis by electrical charges: Yves **Delage**. The eggs are placed in a vessel the base of which forms one plate of an electrical condenser, and submitted to a series of charges. Blank experiments with the electrolytic solution

[1] Examples will be found in Roy. Soc. Proc., A, vol. lxxx., p. 573. The values are not reprinted here, as they were only obtained by the crude method of heating the minerals. This, however, suffices to give the order of magnitude.

used proved conclusively that the latter alone, without the electric stimulation, could not cause the development of the eggs. With the electric charges the eggs developed to the larval stage. The possible causes of this action are discussed, and further experiments promised as regards the effect of the sign of the charge, the voltage, time of application, temperature, &c.—The relative stability of the polycarbonic cyclic groups: Louis **Henry.** In a previous paper the effect of dehydrating dimethyl-isopropyl-carbinol, $(CH_3)_2.C(OH).CH(CH_3)_2$, has been shown to give rise to two isomeric unsaturated hydrocarbons, tetramethyl-ethylene and methyl-isopropylethylene. The dehydration of the closely related cyclic compound, dimethyl-cyclopropyl-carbinol, $\begin{matrix}CH_2\\ |\\ CH_2\end{matrix}\!\!>CH : C(OH)(CH_3)_2$, has now been studied. Acetic anhydride, which readily dehydrates the open-chain compound, transforms the cyclic compound into an acetate, no ethylene hydrocarbons being formed. It is necessary to use a more energetic dehydrating agent, phosphorus pentoxide, to produce the latter action. The action of potassium acetate upon the corresponding bromide gives the acetate instead of ethylene hydrocarbons, as with the open-chain compounds, the trimethylene derivative throughout showing the greater stability.—Systems of families of surfaces cutting along conjugated lines: S. **Carrus.**—Certain properties of curved surfaces: A. **Demoulin.**—The sixth geodetic campaign in the higher regions of the French Alps: Paul **Helbronner.** The atmospheric conditions were not so favourable as in the preceding year, but the remaining six points out of the thirty-two originally planned were determined. The second part of the work comprised the preparations for the triangulation in detail of Haute-Maurienne.—Wehnelt's interrupter: Paul **Bary.** The author develops a theory of the action of the Wehnelt contact breaker based on the production and condensation of vapours in narrow tubes under the action of the current. According to this view the action is not dependent on electrolytic action, but is rather analogous to a hydraulic ram or a pulsometer. The theory gives a good account of the experimental results.—The effects of *Oïdium quercinum* on different species of oaks: Ed. **Bureau.** The species are classified in three groups, those the leaves of which are refractory to the disease, those the younger leaves of which only are attacked, and those all of the leaves of which are attacked.—A seismograph registering electrically at a distance: B. **Galitzine.**

NEW SOUTH WALES.

Royal Society, August 5.—Mr. W. M. Hamlet, president, in the chair.—The pines of Australia, part i.: R. T. **Baker** and H. G. **Smith.** The Australian pines, Callitris, form a distinguishing feature of the landscape in various parts of the continent. In order to investigate their commercial possibilities, a research has been in progress now for some years at the museum, and during this period a very large amount of useful data has been accumulated which it is proposed to publish from time to time. In it is given a full account of the botany and chemistry of the "white or cypress pine," *Callitris glauca*, a species that has the largest geographical range of the genus, occurring in nearly all the States of Australia.—Contributions to the flora of Australia: Dr. A. J. **Ewart** and Miss Jean **White,** assisted by J. R. **Tovey.** The paper contains descriptions of new species and new varieties. It contains also some critical notes on rare and otherwise interesting plants, chiefly from Western Australia, and concludes with some records of introduced plants, together with notes on erroneous records of naturalised aliens.

Linnean Society, July 29.—Mr. J. H. Maiden, vice-president, in the chair.—The genus Nannodythemis (Neuroptera: Odonata), with descriptions of new species: R. J. **Tillyard.** The type of this aberrant genus is *Nannodythemis australis*, Brauer. Two closely allied species, described in this paper, have now been discovered, one from West Australia and the other from the Blue Mountains.—Studies on Australian mollusca, part x.: C. **Hedley.** A series of co-types of rare and unfigured Australian shells was lent to the writer by the British Museum. With their help many difficult points in synonymy are now elucidated, and drawings are presented of a dozen hitherto unfigured shells, inadequate descriptions of which have troubled systematists for more than half a century.—The acidity of milk: Dr. H. G. **Chapman.** The acidity of milk determined within one minute of milking varies from 12° to 19°. The rate at which the acidity increases in milk upon standing was determined. For ten hours there is no increase. The acidity of many samples bought in Sydney was found to be between 12° and 20°. This acidity is not due to lactic acid, but to acid phosphate and dicaseinate.

August 29.—Mr. A. H. S. Lucas, president, in the chair.—Some Sydney desmids: G. I. **Playfair.**—The distribution, origin, and relationships of alkaline rocks: Dr. H. I. **Jensen.**—The alkaline petrographical province of eastern Australia: Dr. H. I. **Jensen.**

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