THURSDAY, FEBRUARY 28, 1895.

WHAT DOES THE CHEMIST MEAN BY "VALENCY"?

Handbuch der Stereochemie. Von Dr. C. A. Bischoff, unter Mitwirkung von Dr. P. Walden. II. Band (Schluss). (Frankfurt: H. Bechhold, 1894.)

THE author of the review of the first part of this book (NATURE, vol. xlix. p. 409) has given an account of it with which the present writer entirely agrees. Dr. Bischoff's book embodies a tolerably complete epitome of all that is known of a subject which at the present time has probably a larger number of cultivators than any other department of chemistry, and as a register of facts and references to original sources of information it is indispensable to the worker engaged upon stereochemical problems. On the other hand, the book is not only eminently unreadable, but the arrangement is sometimes far from clear.

Of this second and concluding volume about one third is occupied with an enumeration, continued from vol. i., of the various known cases of isomerism, inorganic as well as organic, which may be possibly referred to the geometrical hypothesis. The second third deals with chemical changes, such as ring formation and intramolecular changes regarded from the stereochemical point of view. The last part consists of additions to preceding pages, so as to bring the matter up to the most recent date possible. Examination of a volume such as this compels the reflection that spite of the great array of established fact, confusion still prevails among stereochemical writers, chiefly for want of some common agreement as to fundamental ideas.

"Atomicity," as it used to be called, meant originally the power exhibited by the several elements to combine in the proportions of one atom to 1, 2, 3, 4 or *n* atoms of some other element. Hence arose the idea of different atomic values in the process of exchanging one element for another. Later, from these notions about "quantivalence" it was assumed (without sufficient evidence) that when an atom, say, of carbon combines with four other atoms, the force of attraction or union for each of these four atoms is the same. Attempts were then made to estimate by thermal methods the mechanical value of each unit of "atomicity" or "quantivalence."

During all this time much discussion has occurred as to what becomes of units of "valency," to use the more modern term, which are not exercised as in unsaturated compounds generally, and Frankland's idea that even the "bonds" belonging to one and the same atom may saturate each other in pairs has been commonly used.

Since the observations of Van t'Hoff and Le Bel on the relations of chemical constitution to optical activity, and the revival of the hypothesis of spacial arrangements, and especially in the generally adopted theory of tetragonal carbon, the idea of *direction* which is implied in all space arrangements has been universally adopted. As to whether the direction in which valency can act is fixed or variable, opinion seems a little divided, and yet it is obvious that double linkage between two atoms, or the formation of any closed chain of tetragonal carbon atoms (whether conceived according to Van t'Hoff or Wunderlich, or otherwise), would be impossible on the assumption that the valency of carbon atoms can act only in certain directions which are quite fixed. Concerning this question the conclusion seems inevitable that we must suppose something analogous to a magnetic field between combining atoms.

But what, after all, is valency?

The fact is that while one atom of chlorine combines habitually with one atom of hydrogen, an atom of oxygen combines with two atoms of hydrogen, an atom of nitrogen with three, and so forth, and it is hardly assumption to say that so long as the hypothesis of atoms is used to express chemical combination, *some* geometrical arrangement of combined atoms in space is an inevitable part of the hypothesis. This was long ago pointed out by Wollaston. The valency of an element is then the numerical expression of its habit of combination. It is well known to be variable, and to depend to a great extent upon physical conditions. It may be that one atom can only act upon another in certain directions, but this does not render *necessary* the assumption that each atom is always doing something in these several directions, whether other atoms are present or not. This, however, is what is assumed by those who use the term "bond" in any of the recognised senses, or who attempt to determine the dynamical value of units of valency. There is some evidence in favour of the hypothesis that combination can only occur when atoms get within a certain maximum distance from each other, and the possibility that isomerism may result from changes in the distance between the atoms united within a molecule, is deserving of greater consideration than it has hitherto received. If we think, for example, of the exchange of an atom of chlorine for an atom of hydrogen in, say, marsh gas, it is difficult to believe that the chlorine atom occupies exactly the same place relatively to the carbon as the hydrogen atom for which it is substituted. Reasons may possibly be found for this in the difference of the force of "affinity" between carbon and chlorine on the one hand, and between carbon and hydrogen on the other, or it may result from the "residual valency" of chlorine acting upon the neighbouring hydrogen atoms, or from the difference of "mass" of the chlorine and hydrogen. But throughout all the various hypotheses used generally by chemists, runs the idea of direction variable within narrow limits, already referred to. Now, however much the direction along which a force acts may be supposed to vary according to circumstances, it is inconceivable on any mechanical principle that one force can act in several directions at once unless there is reason to suppose that it is divided in some way into component forces. Hence the "centric" formula for benzene, which has lately come into vogue, represents a wholly new idea which is incompatible with previously received ideas about valency and with the hypothesis of the tetragonal carbon atom. According to this formula an atom of carbon is capable of acting in eight different directions—that is, it acts directly, in the conventional sense, upon one atom of hydrogen and upon two atoms of carbon, at the same time that it "influences" these two atoms of carbon and three others. This idea is wholly unnecessary to the explanation of the stability of the benzene

molecule, which can be accounted for quite simply in other ways; but it shows how prevalent is the idea that valency means, not only the power to do something, but that that power is always being exercised, and that in every chemical formula every unit of valency must be accounted for. This example is sufficient to illustrate the state of confusion about valency and chemical combination, which seems to grow more serious and more tangled every day.

The doctrine of Stereoisomerism as at present used may be compared to the fluid theory of electricity. It is a working theory which some day, perhaps, will be superseded, but no great advance is likely to be made until some more clear idea as to the meaning of valency can be brought into use. In the meantime experimental inquiry is undoubtedly proceeding rapidly, and will prepare the way for the next step in theory. To this end such a book as Bischoff's "Stereochemie" will afford much assistance in the laboratory, and can be safely recommended to all who are working in this direction. W. A. T.

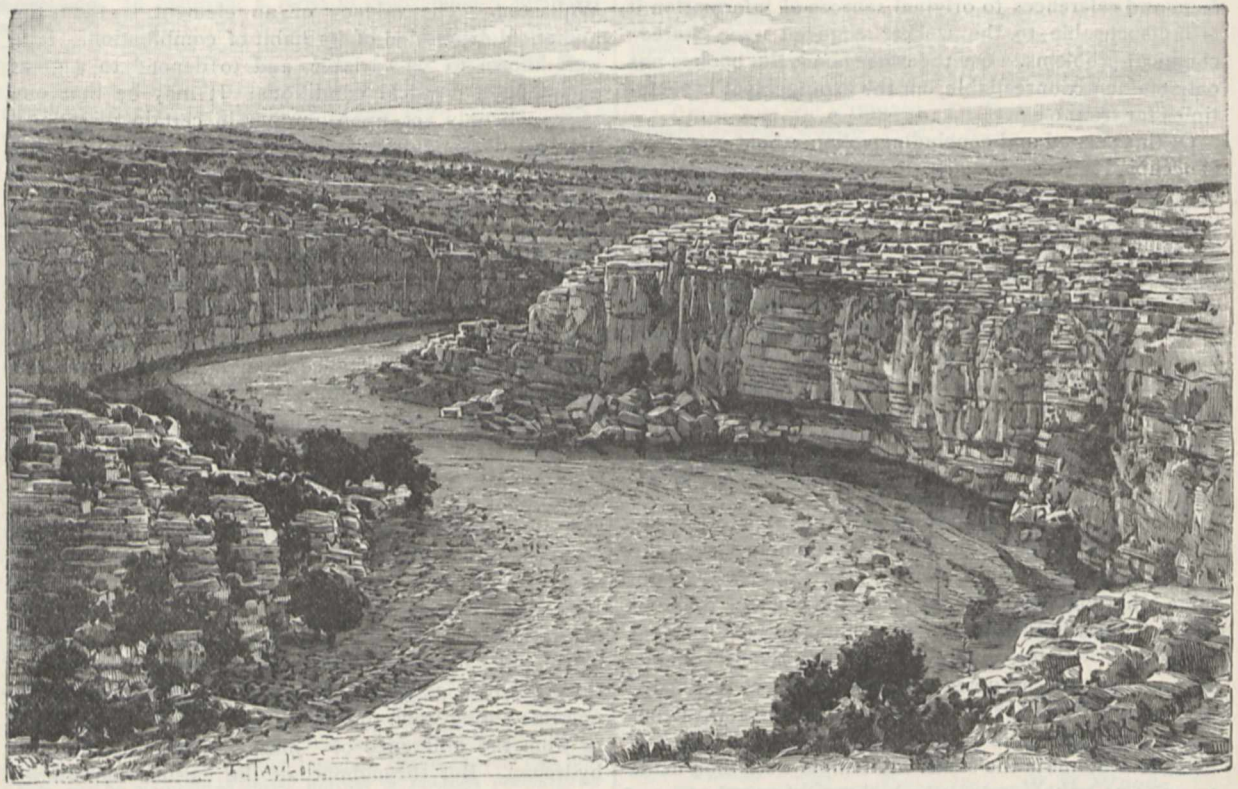


FIG. 1.—Cañon de la Baume.

CAVES AND SWALLOW-HOLES.

Les Abîmes, les eaux souterraines, les cavernes, les sources, la spelæologie. By E. A. Martel. 4 phototypes and 16 plans, with 100 smaller illustrations. (Paris: C. Delagrave, 1894.)

AT the outset the author remarks that the man is happy who realises in ripe manhood a project of boyhood. As a youth he was fascinated by the stalactites of the cave of Gargas, and the underground stream near Eaux Chaudes. The impression, at a later date, was deepened by the marvels of Adelsberg; and a visit to Han-sur-lesse (Belgium) in 1888, determined him to explore thoroughly the swallow-holes and caves of Les Causses—the limestone plateaux to the south and west of the Cevennes and Auvergne—with which he had already made acquaintance. Here the rivers often flow through deep gorges—almost cañons, such as is illustrated by Fig. 1. In 1888 and the following year the author investigated the underground topography of the Departments of Lozère and Gard, and then extended his researches from Vaucluse to La Charente, going as far as the Puy-de-Dôme, the Côte-d'Or, and Provence, and, yet further afield, to Belgium, the Karst, and the Peloponnesus. Altogether he explored 230 "holes in the rock," which he thus classifies: Swallow-holes (*abîmes*), 110, into 90 of which no descent had been previously made; emissaries of rivers (*sources*), 40, up 30 of which no one had penetrated; caves, 80, of which 45 were but imperfectly known. Besides these he had sounded, without descending, 35 swallow-holes, and examined 55 large emissaries, which could not be entered. Plans were made of underground galleries, the total length of which amounts to 50 kilometres; rather more than half the work being done by himself, the rest by collaborators. The result of this indefatigable, and sometimes rather risky, work is the most complete original memoir on "cave hunting" that has ever been published, a quarto volume of nearly 600 pages, containing many plans, and still more numerous illustrations, the latter mostly from photographs, together with a full bibliography of the subject.

To give any account of even the caverns of the Causses, which occupy the larger part of the book, would occupy too much space; so we content ourselves with a brief sketch of one of the most remarkable—that of Padirac, in the Causse de Grammat; and, after all, caves generally exhibit a strong family likeness. On a rocky plain a gulf, nearly forty yards across, opens out suddenly, as shown in Fig. 2, for which and the one on p. 410, we are indebted to the courtesy of the publishers. The greatest depth is just over twice the breadth, but a huge pile of débris rises from the bottom up to nearly fifty-nine yards from the surface. This leads on either side to a gallery. One of these ascends gently upwards, for about a couple of hundred yards, to a spot where a stream bursts from the rock. The other gallery,

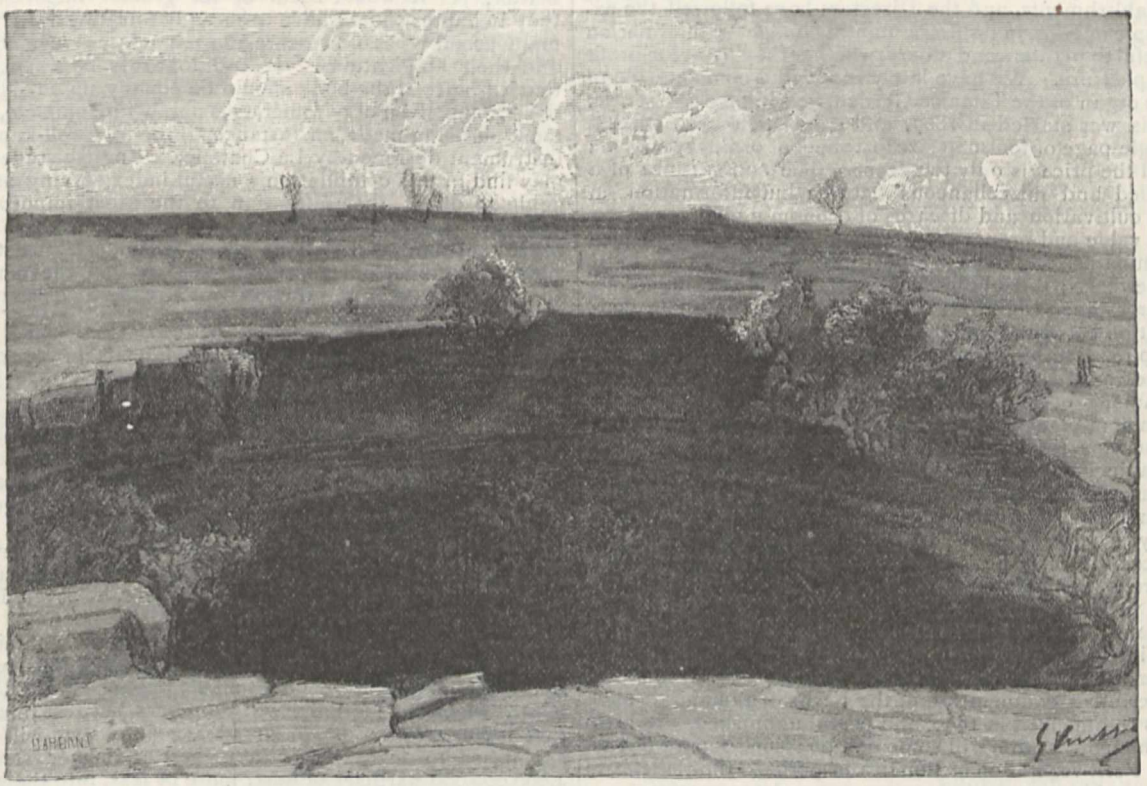


FIG. 2.—Shaft leading to the Cave of Padirac.

which is also traversed by this stream, extends for about a mile and three-quarters, following a rather serpentine course, which, in one part, bends at right angles to its former direction. At last it ends in a lake and a *cul de sac*. The cave is generally rather narrow, not many feet in width, but here and there broadens out into a large hall; the roof, also, rises and falls, its height not unfrequently being from forty to sixty feet—occasionally a good deal more. Padirac contains stalacites, stalagmites, and basin-shaped deposits of calcic carbonate; in short, is a thoroughly typical cave, with the not infrequent addition of a huge swallow-hole. Dozens of similar caverns may be found in this curious limestone region. They are abundant, under various names, in the Jura and in the limestone districts of the Alps, being most frequent in the more eastern region, where sometimes a bare rocky tract is almost riddled by swallow-holes (*dolinas*) great or small. From the Karst district they may be followed through the Alps of Dalmatia into the limestone region of Greece; they exist also in the carboniferous limestone of England, Belgium, and America. One might almost say *ubi calx, ibi spelunca*.

M. Martel notices, but appears to have paid less attention to, the curious caves called *glacières*, so pleasantly described by Canon Browne in his "Ice Caves of France and Switzerland." In these the walls are hung with sheets and festoons of ice, and thick masses of it cover the floors. In summer-time the temperature inside them keeps very near to the freezing-point. M. Martel suggests that in winter they become filled with cold air, which remains there like the carbonic anhydride in a *grotto del cane*. But such as we have seen, appear to be better explained as natural ice-houses, where the summer warmth is insufficient to dispose of the snow and ice which had accumulated in the winter.

Is it possible that occasionally these swallow-holes and caves may be memorials of an age when the climate was colder than it is at present? Both are sometimes dry. In the case of the cave, this may be explained by the water having worked out a new, and as yet undiscovered, path; but some swallow-holes open out, like the mouths of wells, on gentle slopes or rocky plains, apparently disconnected from any system of drainage. They seem too large to be explained—like those countless pipes in

the rock of the *Steinerne Meer*—as only the work of rain. Is it possible that they were chiefly excavated in the Glacial epoch, when many elevated rocky plateaux would be buried under permanent, or nearly permanent, snow-beds, the drainage from which would give a supply of water, which was engulfed before it had the opportunity of excavating a glen? Some things seem not unfavourable to this suggestion. T. G. BONNEY.

OUR BOOK SHELF.

Bulletin of the Botanical Department, Jamaica. April 1887 to September 1894. Edited by the Director, W. Fawcett, B.Sc. (Published by the Department of Public Gardens and Plantations.)

SINCE the increase of botanical stations in the British West Indies, there has been greater activity in the older establishments, and the Directors have followed the example of Kew, in issuing a monthly budget of information useful to planters and others, whether they plant for profit or pleasure. We have lately received a complete file of the organ of the Jamaica Garden, bearing the above title. This was started in 1887, and it has increased from a single page of foolscap size to a sheet of ordinary octavo; and the price is only twopence. The contents are of a varied and miscellaneous nature; but information on the cultivation and diseases of economic plants, and on the value and preparation of their products, largely predominates. It includes not only the results of local experience; the editor has also drawn upon the numerous sources open to him, thanks to the more intimate connection between similar establishments throughout the empire, due, to a large extent, to the efforts of the Director of Kew.

Among other things, there are lists of the economic plants, of plants yielding edible fruits, and of trees useful either for timber or shade, cultivated in the Jamaica botanic garden. Botanical and common names are given, as well as the native countries of the respective plants, together with the prices (of seeds or plants) at which they are offered to the inhabitants of the island. The prices, it may be mentioned, are ridiculously low; merely nominal, in fact. Free grants are also made; but in order to avoid waste of valuable plants, the conditions are somewhat stringent, though not more so than an intelligent and earnest cultivator would cheerfully submit to. Another interesting feature is Mr. Jenman's descriptive enumeration of the Ferns of Jamaica. This was commenced in 1890, and is still unfinished. It is to be hoped that this will some day be issued separately, as the Fern-vegetation of Jamaica is perhaps the richest in the world, comprising between 400 and 500 species.

Die Maschinellen Hilfsmittel der Chemischen Technik. Von A. Parnicke, Civil-ingenieur, vorm. Ober-ingenieur der Chemischen Fabrik Griesheim. (Frankfurt: H. Bechhold, 1894.)

WE are accustomed to hear little but praise of the German University system of education. There is, however, a reverse to the shield. While admitting the value of the training received by the University student in pure chemistry, the author of this work points out that only in a few of the higher technical schools is any systematic instruction given concerning the employment of machinery in manufacturing chemistry. The consequence is that many young chemists find, at the commencement of their practical career, that they have either to laboriously collect, from many scattered and not easily accessible sources, the information they require, or perforce remain mere copyists of the methods of others, for lack of the knowledge which might enable them to intelligently use the mechanical appliances best suited to attain their ends.

The work under review represents an endeavour to lessen the difficulties in this direction. In some 290 pages, a synopsis is presented of the principal mechanical arrangements with which the chemist may be concerned. A vast amount of information is set out in well-arranged sequence, and, though many of the descriptions are necessarily somewhat sketchy on account of the large number of appliances to be described, a study of the pages before us cannot fail to be of great use to the limited class for whom they were written. The book is well illustrated, having no fewer than 337 figures; these would have possessed a much greater value had dimensions been more generally given. From the point of view of the highly-trained chemist, it is perhaps to be regretted that valuable space is occupied by descriptions of certain machines of well-known types, such as common weighing machines. No doubt the volume is rendered more complete by the inclusion of such matter, yet it would seem of far greater importance that a chapter should have been added dealing with the many useful types of pressure and temperature regulators and their applications. It could hardly be expected that all parts of the book should be equally up to date; the account given of pyrometers is notably incomplete, no mention being made, for instance, of the now well-known instrument designed by Le Chatelier. English students may find in this compilation a useful index serving as a guide to direct their attention to the most important mechanical devices used in chemical operations; but we think that they will benefit more by undertaking the additional labour of unearthing details from the many admirable treatises and dictionaries already in existence in their own language. W. T.

Air, Water, and Disinfectants. (Manuals of Health Series.) By C. M. Aikman, M.A., D.Sc. Pp. 126. (London: S. P. C. K., 1895.)

THIS little book contrives to tell us a great many most interesting and instructive facts, without for one moment running the risk of boring us. It is written in an attractive style, and whilst popular, the author never forgets what is due to the subjects he is discussing.

Microbes, not perhaps, without reason, furnish material for a substantial portion of the text, and free use is made of "Our Secret Friends and Foes," which, however, Dr. Aikman amply acknowledges.

The little section on "Dust particles in the air" contains an interesting *résumé* of Dr. Aitken's investigations, and as they have been, we believe, chiefly published in Edinburgh scientific journals, will doubtless suggest much that is novel to the general reader. Many such will be astonished to learn "that a cigarette smoker sends 4,000,000,000 particles of dust, more or less, into the air with every puff he makes," and that one cubic inch of the air of a room at night, when the gas is burning, may contain as many dust particles as there are inhabitants of Great Britain!

We cordially recommend this little book to all those who wish to obtain an accurate, though popular, idea of the nature of air, water, and disinfectants.

An Elementary Text-book of Anatomy. By Prof. H. E. Clark. (London: Blackie and Son, 1895.)

A TEXT-BOOK of anatomy, suitable as an introduction to junior students of medicine, and simple enough to be understood by all who wish to read about the structure of their bodies. The book is limited to the anatomy of the human subject, and is divided into seven sections, dealing respectively with the tissues, bones, joints, muscles, vessels (the heart, blood-vessels, and lymphatic vessels), nervous system, and internal organs. It contains numerous instructive illustrations, as well as a useful glossary, and is altogether a serviceable elementary manual of anatomy.

case is, that H_1 lies in a part of the curve ascending to or descending from a higher summit. Then the ordinates on the one side of H_1 will be greater, and on the other less than H_1. But because higher summits are so extremely improbable, the first case will be the most probable, and if we choose an ordinate of given magnitude H_1 guided by haphazard in the curve, it will be not certain, but very probable, that the ordinate decreases if we go in either direction.

We will now assume, with Mr. Culverwell, a gas in a given state. If in this state H is greater than H (min.) it will be not certain, but very probable, that H decreases and finally reaches not exactly but very nearly the value H (min.), and the same is true at all subsequent instants of time. If in an intermediate state we reverse all velocities, we get an exceptional case, where H increases for a certain time and then decreases again. But the existence of such cases does not disprove our theorem. On the contrary, the theory of probability itself shows that the probability of such cases is not mathematically zero, only extremely small.

Hence Mr. Burbury is wrong, if he concedes that H increases in as many cases as it decreases, and Mr. Culverwell is also wrong, if he says that all that any proof can show is, that taking all values of dH/dt got from taking all the configurations which approach towards a permanent state, and all the configurations which recede from it, and then striking some average, dH/dt would be negative. On the contrary, we have shown the possibility that H may have a tendency to decrease, whether we pass to the former or to the latter configurations. What I proved in my papers is as follows: It is extremely probable that H is very near to its minimum value; if it is greater, it may increase or decrease, but the probability that it decreases is always greater. Thus, if I obtain a certain value for dH/dt, this result does not hold for every time-element dt, but is only an average value. But the greater the number of molecules, the smaller is the time-interval dt for which the result holds good.

I will not here repeat the proofs given in my papers; I will only show that just the same takes place in the much simpler case of dice. We will make an indefinitely long series of throws with a die. Let A_1 be the number of times of throwing the number 1, among the first $6n$ throws, A_2 the number of times of throwing 1, among all the throws between the second and the $(6n+1)$th inclusive, and so on. Let us construct a series of points in a plane, the successive abscissæ of which are

$$0, \frac{1}{n}, \frac{2}{n}, \frac{3}{n}, \ldots,$$

the ordinates of which are

$$y_1 = \left(\frac{A_1}{n} - 1\right)^2, y_2 = \left(\frac{A_2}{n} - 1\right)^2 \ldots;$$

let us call this series of points the "P-curve." If n is a large number, the greater proportion of the ordinates of this new curve will be very small. But the P-curve (like the aforementioned H-curve) has summits which are higher than the ordinary course of the curve. Let us now consider all the points of the P-curve, whose ordinates are exactly $= 1$. We will call these points "the points B." Since for each point $y = (A/n - 1)^2$, therefore for the points B we have $A = 2n$; these points mark, therefore, the case where, by chance, we have thrown the number 1 in $2n$ out of $6n$ throws. If n is at all large, that is extremely improbable, but never absolutely impossible. Let v be a number much smaller than n, and let us go forward from the abscissa of each point B through a distance $= 6v/n$ in the direction of x positive. We shall probably meet a point, the ordinate of which < 1. The probability that we meet an ordinate > 1 is extremely small, but not zero. By reasoning in the same manner as Mr. Culverwell, we might believe that if we go backward (*i.e.* in the direction of x negative) from the abscissa of each point B through a distance $= 6v/n$, it would be probable that we should meet ordinates > 1. But this inference is not correct. Whether we go in the positive or in the negative direction the ordinates will probably decrease.

We can even calculate the probable diminution of y. We have seen that for every point B we have $A = 2n$ (*i.e.* $2n$ throws out of $6n$ turning up 1). If we move in the positive or negative direction along the axis of x through the distance $1/n$, we exclude one of the $6n$ throws, and we include a new one. When we move forward through the distance $6v/n$, we have excluded $6v$ of the original throws, and included $6v$ others. Among the excluded throws we have probably $2v$, among the included ones v throws of the number 1. Therefore the probable diminution of A is v, the probable diminution of y is $2v/n$ approximately. Because the variation of x was $6v/n$, we may write

$$\frac{dy}{dx} = -\frac{1}{3}.$$

But this is not an ordinary differential coefficient. It is only the average ratio of the increase of y to the corresponding increase of x for all points, whose ordinates are $= 1$. The P-curve belongs to the large class of curves which have nowhere a uniquely defined tangent. Even at the top of each summit the tangent is not parallel to the x-axis, but is undefined. In other words, the chord joining two points on the curve does not tend towards a definite limiting position when one of the two points approaches and ultimately coincides with the other.[1] The same applies to the H-curve in the Theory of Gases. If I find a certain negative value for dH/dt, that does not define the tangent of the curve in the ordinary sense, but it is only an average value.

§ 3. Mr. Culverwell says that my theorem cannot be true because if it were true every atom of the universe would have the same average *vis viva*, and all energy would be dissipated. I find, on the contrary, that this argument only tends to confirm my theorem, which requires only that in the course of time the universe must tend to a state where the average *vis viva* of every atom is the same and all energy is dissipated, and that is indeed the case. But if we ask why this state is not yet reached, we again come to a "Salisburian mystery."

I will conclude this paper with an idea of my old assistant, Dr. Schuetz.

We assume that the whole universe is, and rests for ever, in thermal equilibrium. The probability that one (only one) part of the universe is in a certain state, is the smaller the further this state is from thermal equilibrium; but this probability is greater, the greater is the universe itself. If we assume the universe great enough, we can make the probability of one relatively small part being in any given state (however far from the state of thermal equilibrium), as great as we please. We can also make the probability great that, though the whole universe is in thermal equilibrium, our world is in its present state. It may be said that the world is so far from thermal equilibrium that we cannot imagine the improbability of such a state. But can we imagine, on the other side, how small a part of the whole universe this world is? Assuming the universe great enough, the probability that such a small part of it as our world should be in its present state, is no longer small.

If this assumption were correct, our world would return more and more to thermal equilibrium; but because the whole universe is so great, it might be probable that at some future time some other world might deviate as far from thermal equilibrium as our world does at present. Then the afore-mentioned H-curve would form a representation of what takes place in the universe. The summits of the curve would represent the worlds where visible motion and life exist.

LUDWIG BOLTZMANN.

Imperial University of Vienna.

Oysters and Typhoid.

WITH reference to the article "Oysters and Typhoid," which appeared in your last issue, it may interest your readers to know that De Giaxa investigated some years ago the behaviour of the typhoid bacillus in sea-water, both in its natural and sterilised condition. He found that in ordinary sea-water the typhoid bacillus suffered very considerably in the competition with the numerous other water bacteria present, but it was still identified on the ninth day after it was first introduced. In sea-water in which all other bacteria had been destroyed, the typhoid bacillus was detected in very appreciable numbers on the twenty-fifth day. More recently, however, the existence of typhoid bacilli in sterilised sea-water has been examined by Cassedebat, and his results are not in accord with those obtained by Giaxa. Cassedebat found that whilst many pathogenic

[1] See Ulisse Dini, "Grundlagen für eine Theorie der Functionen einer reellen Veränderlichen" (Teubner, 1892, § 126), or Weierstrass, *Journal für die Mathematik*, Band 79, p. 29.

bacteria, amongst which were those of anthrax and cholera, lived for several days, in the case of the former twenty-one to twenty-four days, and in that of the latter thirty-five days and even longer, typhoid bacilli were destroyed already in the course of forty-eight hours in sterilised sea-water. These results tend to confirm those obtained by Prof. Percy Frankland, who, in his last report to the Royal Society Water Research Committee, states that the addition of 1 and 3 per cent. of common salt to ordinary Thames water into which typhoid bacilli were introduced, acted very prejudicially on the latter, although it stimulated the multiplication of many forms of water bacteria present in a most astonishing manner. Similar results were obtained with salted but sterilised Thames water infected with typhoid bacilli, and not only did the latter disappear very rapidly, but the typhoid colonies which were obtained on plate-cultures from this salt water exhibited in some cases a very abnormal appearance, attributable to the degeneration of the typhoid bacilli under these conditions, for on passing such colonies through a further process of plate-culture, they returned to their ordinary type.

Giaxa also experimented with fish, introducing pathogenic microbes *per os*. Unfortunately, he did not select the typhoid bacillus for these experiments, but took instead cultures of cholera and anthrax bacilli. He found that in both cases these micro-organisms were entirely destroyed in the course of a few hours. Experiments were also made with oysters and some varieties of mussel-fish. A small hole was bored in the shell, and vigorous broth cultures of anthrax and cholera bacilli were respectively introduced, after which the aperture was carefully closed with sealing-wax, and whilst some of the molluscs were replaced in sea-water, others were kept in glass dishes without any water. The latter lived for two days under these conditions. Six hours after the injection had taken place, and again at the end of twenty-four and forty-eight hours, the sealing-wax was removed and a small quantity of the fluid within the shell was taken out and plate-cultures made. In the majority of the experiments these pathogenic microbes had completely disappeared in six hours, whilst in only two instances were they detected in small numbers at the end of twenty-four hours, and in no case were they identified after forty-eight hours. These results were irrespective of whether the mollusc was kept in or out of water. In these investigations, therefore, there would appear to be no evidence that these pathogenic microbes (cholera and anthrax) were capable of being transmitted by means of these shell-fish. So far as I am aware, no one has followed up these interesting experiments, and in view of the serious allegations which have lately been made against oysters as transmitters of typhoid fever, it is a subject which might well claim re-investigation.

February 13. G. C. FRANKLAND.

The Occurrence of very Cold Days.

IT is usual to estimate cold by minima of temperature. But we may also consider it as expressed in maxima. A day may fairly be called "very cold" in which the maximum is not over freezing point. I propose to offer some account of the occurrence of such days at Greenwich in the fifty winter seasons (November to March) 1844–5 to 1893–4. (For brevity, I will designate each winter by the year in which it begins.)

These very cold days are not very frequent. In some winters there are none. The highest number is 27. The list is as follows :—

1844 ... 13	1861 ... 5	1878 ... 18
45 ... —	62 ... —	79 ... 10
46 ... 11	63 ... 4	80 ... 12
47 ... 4	64 ... 5	81 ... —
48 ... 2	65 ... —	82 ... 2
49 ... 7	66 ... 12	83 ... —
50 ... —	67 ... 6	84 ... 1
51 ... —	68 ... 1	85 ... 3
52 ... —	69 ... 8	86 ... 5
53 ... 4	70 ... 10	87 ... 5
54 ... 15	71 ... 1	88 ... 2
55 ... 4	72 ... 1	89 ... 1
56 ... 3	73 ... 3	90 ... 27
57 ... 2	74 ... 5	91 ... 5
58 ... 1	75 ... 4	92 ... 9
59 ... 6	76 ... —	93 ... 5
60 ... 9	77 ... —	
		Total ... 251

The total, 251, gives an average of 5·02 for each season. Ten of the winters had none of those days, and fifteen had numbers over the average.

The distribution in months was as follows :—

	November.	December.	January.	February.	March.
	6 ...	96 ...	111 ...	34 ...	4
Average	— ...	1·92 ...	2·22 ...	·68 ...	—

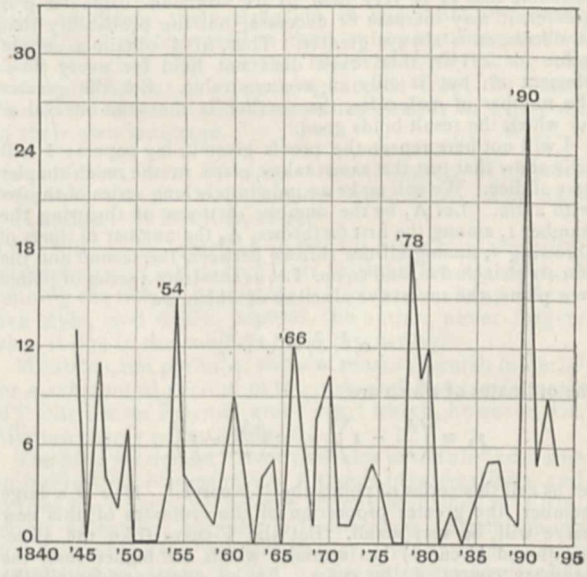
Such days are rare in November; and still more rare in March. The six cases in the former month were in 1849, 1858, 1861, 1887, and two in 1890; the earliest in the month being that in 1887 (16). The four cases in March were all in one year, 1845. January has most of such days (about 17 per cent. more than December).

The largest number in any one month was sixteen in December 1890; the next, twelve in January 1867 and January 1881.

We might perhaps note that relative maxima of the seasonal numbers occurred in 1854 (15), in 1866 (12), in 1878 (18), and in 1890 (27); giving three intervals of twelve years.

Measured by mean temperature of the three winter months, these winters were all severe (considerably under average) except 1866; in which, though January (1867) was very cold, December and February were both mild (the latter uncommonly so); thus the winter was above the average of mean temperature.

Days with Maxima not over 32° at Greenwich.



These very cold days most often come in groups (two or more in succession). The largest group was 10 in December '90; the next, 9 in January '81; then 6 in December '44, December '59, and January '93, &c.

Of the 251 days, 100 had maxima from 31° to 32°; 51 from 30° to 31°; 42 from 29° to 30°; 23 from 28° to 29°; 14 from 27° to 28°; and 21 under 27°, ranging down to 19°. The corresponding minima range from 29°·6 down to 7°·7, with greatest density about 22° to 24° (45 cases).

How are the maxima related to their respective minima? There is, of course, no rigorous proportionality; and we may often find high maxima with very low minima (*e.g.* December 29, '60, max. 31°·8, min. 10°·0), as also low maxima with relatively high minima (*e.g.* January 15, '50, max. 26°·9, min. 25°·9). On an average, however, high minima go with high maxima, and low with low. Take the following:

I selected the cases in which the maxima was under 27°; there are 21. Of the corresponding minima only four were *over* 20°. On the other hand, taking the last 21 (of 46) cases in which the maximum was over 31°·5, one finds only four minima *under* 20°. The average minimum in the former case was 16°·4; in the latter 24°·4. The average difference of maxima and minima was in both cases about 8°.

It may be useful to put down a number of the coldest of these days (reckoned by maxima). Here are 12 :

	Max.	Min.	Diff.
	°	°	°
1. Jan. 5, '94 ...	19·0	12·8	6·2
2. Jan. 4, '67 ...	21·2	7·7	13·5
3. Dec. 21, '55 ...	23·2	17·0	6·2
4. Dec. 22, '90 ...	23·7	13·4	10·3
5. Dec. 22, '55 ...	24·2	16·9	7·3
6. Jan. 10, '91 ...	24·4	12·0	12·4
7. Dec. 31, '74 ...	24·5	18·5	6·0
8. Jan. 7, '94 ...	24·5	18·1	6·4
9. Jan. 16, '81 ...	24·6	17·7	6.9
10. Jan. 15, '81 ...	24·8	14·0	10·8
11. Mar. 13, '45 ...	24·8	13·1	11·7
12. Jan. 14, '67 ...	24·9	13·9	11·0

These minima, it will be seen, range from 7°·7 to 18°·5. I do not enter on the question as to the coldest days measured by minima; but from a table by Mr. Charles Harding, giving the minimum at Greenwich in each winter, 1841–89 (*Quart. Journ. of R. Met. S.* vol. xvi. p. 165), extended to '93, I take the following cases (adding the maxima since '44) :

	Min.	Max.	Diff.
	°	°	°
(Jan. 9, '41 ...	4·0)		
1. Jan. 5, '67 ...	6·6	32·5	25·9
2. Feb. 12, '45 ...	7·7	29·3	21·6
3. Dec. 25, '60 ...	8·0	30·0	22·0
4. Dec. 25, '70 ...	9·8	28·2	18·4
5. Feb. 19, '55 ...	11·1	33·4	22·3
6. Feb. 12, '47 ...	11·2	39·6	28·4

The lowest (4°·0) was in '41, and so beyond our fifty years' limit. It will be observed that those six maxima are all higher than any in our first list, exhibiting a wide range in the temperature of the very cold days thus measured.

In the present remarkable season, there have been, up to February 27, 17 of our "very cold" days, viz. 6 in January, and 11 in February (an unprecedented case). The lowest maximum is 27°·0, occurring on February 6, 7, and 9; the respective minima, 15°·1, 9°·6, and 10°·2. A. B. M.

Hesper and Phosphor.

IN his "History of the Inductive Sciences" (vol. i. p. 149, London, 1847), Whewell says:—"Pythagoras is said to have maintained that the evening and morning stars are the same body, which certainly must have been one of the earliest discoveries on this subject; and indeed, we can hardly conceive men noticing the stars for a year or two without coming to this conclusion" (*cf.* "The Planet Venus," by W. J. L., in NATURE, vol. xlix. p. 413). Now, what Whewell deemed so hardly conceivable appears to have actually occurred in old China. Wang Chung, the philosopher (*circa* 27–97 A.D.), in his work, renowned for its total repudiation of the then current errors, writes as follows :—"In the 'Book of Poems' it is said, '*Ki-ming* (Phosphor) exists in the east, and *Chang-kang* (Hesper) in the west.' In fact, however, they are but the phases of Jupiter and Venus, which, appearing now in the east, now in the west, received such distinct names from the ignorant bards" ("Lun-hang," Miura's edition, Kyôto, 1748, tom. xvii. pp. 12–13). Two facts are manifested in this passage. First, it shows that, celebrated for their astronomical acquirements in very archaic ages, as they are, the fact that the evening and morning stars are the same body, was not known to the Chinese of the eighth century B.C., when the poem entitled "Ta-tung" was composed, comprising the above-quoted line. Secondly, it shows that, even after the identity was established of the evening and morning stars, some Chinese, so well learned as Wang Chung, were ignorant of their own error: affirming that Jupiter as well as Venus appears now as Phosphor, now as Hesper, they have admitted the existence of two distinct Phosphori and two distinct Hesperi, and of a Phosphor essentially different from a Hesper. It is probable that some later scholars have tried to evade this intricacy by arbitrarily apportioning the two phases between the two planets; thus, Minamoto-no-Shita-zau, the Japanese poet and glossarist (909–983 A.D.), referring to a Chinese work "Kien-ming-yuen," which is perhaps lost now, identifies Jupiter (in Chinese: Sui-sing) with Phosphor (in Japanese: Aka-boshi), and Venus (in Chinese: Tai-peh) with Hesper (in Japanese: Yûtsutsu) ("Wamyô Ruijushô," Nawa's edition, Kyôto, 1667, tom. i. p. 1).

February 22. KUMAGUSU MINAKATA.

The Recent Storm in the United States.

THE storm of February 4–9 in the United States was notable for its extent and severity, recalling the memorable blizzard of March 1888. The Government Weather Bureau gives the following comparison of the two :—

	1888.	1895.
Snow	2 feet	5½ inches
Wind	50 miles	60 miles
Temperature at New York	4·8 above	3 below
Area	400 miles radius	1600 miles radius

It will be seen that the recent storm was more severe in everything except the amount of snow, and far more extensive. The entire southern portion of the country experienced severe cold, destroying fruits and vegetables to the value of 15,000,000 dols. in Florida alone. The zero line extended below the middle of Arkansas, and well down into Texas.

The storm reached New York on Thursday, February 7. On the previous afternoon, at about four o'clock, I observed at Brooklyn the unusual phenomenon of a double rainbow.

Brooklyn, February 11. WM. H. HALE.

SOME SUGGESTIONS ON THE ORIGIN AND EVOLUTION OF WEB-SPINNING IN SPIDERS.

IT cannot be reasonably doubted that one of the most interesting features connected with the natural history of spiders, is their habit of gaining a livelihood by spreading nets for the capture of prey. It may be that the large share of the attention of naturalists that this habit has attracted, is to be attributed to the fact that it appears to be confined in the animal world to spiders and men. This circumstance is of itself sufficiently remarkable to call for special comment; but its interest is not a little enhanced by the reflection, that since spiders made their appearance in the history of animal life vast ages before man came upon the scene, none of us can justly claim that any member of our own kind was the first in the field in the invention of the art of netting. Possibly, indeed, the oft-repeated and unavoidable observation of the efficacy of a spider's web for the purpose of catching otherwise unobtainable prey, may have roused in the brain of some intelligent hunter amongst our ancestors, the idea of the practical utility of a similar instrument for the capture of fish or other eatable forms of life. But if this be so, civilised man has long forgotten the debt of gratitude he owes to spiders. For, to the average individual amongst us, a spider is a thing to be looked upon and spoken of with fear and dislike amounting to loathing, and to be ruthlessly destroyed when a safe chance of destruction is afforded.

It is, perhaps, on account of this widespread repugnance that the science of arachnology has claimed within the last century far fewer students than many another less instructive branch of zoology. Moreover, such attention as it has received, is no doubt largely due, as suggested above, to the wonderful web-building powers that spiders possess. But those who have devoted their time to the study of webs, have, for the most part, contented themselves with observing and recording the structure and method of formation of the various types of nests and snares, and in claiming or disputing their value as a basis for a natural classification of the animals that make them. This has resulted, if in nothing else, at least in the accumulation of an array of facts sufficiently vast to

make it possible to attempt to weave them into a coherent and intelligible whole, by trying to trace the origin and evolution of the habit of net-spinning. It is strange that but a small number of students seem to have occupied themselves with this most attractive aspect of the subject. With the exception, indeed, of a few authors who have here and there thrown out stray suggestions upon particular points, no one appears to have seriously set himself to the elucidation of the whole problem. It is true that in the second volume of his work upon the American orb-weaving spiders, Dr. McCook devotes a chapter to the "genesis of snares"; but since he does not appear to be able to attach great importance to the evidence in favour of evolution, his treatise on the subject practically resolves itself into a demonstration of the fact that, by starting at any point you please, in what is called "aranead spinning work," a series of gradations may be traced from one modification of architecture to another, from the simplest to the most complex, or from the most complex to the simplest. He thus succeeds in leaving his readers completely in doubt as to whether or not he intends one or all of his attempts at tracing the "genesis" of snares to represent what has actually occurred in the course of nature; and one closes the chapter without satisfactorily ascertaining if its writer has any definite views respecting a primitive form of spinning work. Yet, at the same time, it must be admitted, an impression remains that the suggestions that are put forward, based as they are upon an extensive knowledge of the subject, point in more than one instance to the true lines along which the web-spinning habits have been evolved.

In attempting to arrive at an understanding of the origin of any structure or instinct in an animal, one nowadays naturally refers for an explanation to what is hypothetically its ancestor, or, failing this, its ancestor's nearest ally. If this method of research be adopted in connection with the spinning powers of spiders, it is found that silken threads are fabricated by two allied groups of animals, both of which are believed by some students to stand, in many respects, nearer than spiders do to the ancestor of the class to which spiders, scorpions, mites, &c., belong. In one of these—the Chelifers, or book-scorpions—the presence of silk glands has long been known. In the other—the *Phrynidæ*—their existence is now, for the first time, I believe, pointed out. The function of the silk in the Chelifer is cocoon-spinning; and that it is materially the same in the *Phrynidæ* is shown by the easily verified fact, that the egg-case of the mother is secured to the lower surface of her abdomen by fine silk-like threads. One of the chief interests of this discovery lies in the circumstance, that of existing animals the *Phrynidæ* appear to be most nearly allied to the immediate ancestor of the spiders. We are, therefore, justified in concluding that originally the silk in spiders was utilised for the purpose of making a case for the eggs.

If, however, we consider the question from the standpoint of spiders alone, it seems to me that we should naturally arrive at the same result. For it is, *à priori*, probable that the primitive form of spinning industry was that particular kind which is now common to all groups. But when we pass in review the spinning work of the various tribes of spiders, we find that the habits of utilising the silk for constructing a snare, or drag-lines, for enswathing captured prey, or for purposes of locomotion, do not occur, by any means, invariably throughout the class. In fact, we cannot say of any one of them that it is characteristic of spiders. Not so, however, is it with cocoon-spinning. For, however different from each other in structure spiders may be, and however dissimilar in habits and mode of life, we yet find that the instinct of the mother to spin a cocoon for the protection of her eggs is never wanting.

Granting, then, the possession of silk-glands inherited from an ancestor, we may conclude that the first step in the development of web-spinning was the formation of the cocoon. What was the second? We know that a spider's care for her eggs does not, as a rule, cease with the completion of the cocoon: some species carry it about with them; others mount guard in its vicinity. Possibly the former was the original method of disposing of it. But if so, since such a habit must more or less impair the mother's activity and must render her a conspicuous object of attack, we can understand why it has been abandoned for the latter method by the great majority of spiders, and is now almost confined to those species in which the nomadic mode of life reaches its highest development. If, on the other hand, as seems more likely, the primitive habit was that of watching by the cocoon, we can understand that during the temporary period of quiescence thus enforced, the mother would naturally seek concealment and protection for herself; and since she possessed the instinct and material for constructing a receptacle for her eggs, it is possible to see how a slight modification of intelligence might have led her to extend the same protection to herself by weaving a covering over and around the retreat in which she had sought refuge. Then if an aperture for ingress and egress, for purposes of feeding, were left at any spot in the wall of such a protective domicile, there would arise, in a rudimentary form, what is known as the tubular nest or web. And the next simple but important step would doubtless be the adoption of the silken tube as a permanent abode for the mother after the dispersal of the young to shift for themselves.

As a matter of fact, some spiders have advanced no further than this stage. The females of some *Drassidæ*, for instance, spin a temporary retreat for themselves and their young at the breeding season; while others utilise the retreat as a permanent dwelling-place. Lastly, the view that the formation of a tubular retreat was in reality the second stage in the evolution of web-spinning, seems supported by the circumstance that the tube, whether accompanied or not by accessory developments, is, with the exception of the cocoon, the most constant feature in the spinning industry of spiders.

Adopting then, for these reasons, the conclusion that a simple tube was the primitive form of nest, it seems that the evolution of web-spinning has been carried out along two main lines. Along one there is a gradual elaboration of the tube until it culminates, so far as structural complexity is concerned, in the trap-door nest with which everyone is familiar; along the other, the tubular nest either ultimately disappears, or, retaining its primitive simplicity, it is to a greater or less extent superseded by the formation of a new structure—namely, the net for ensnaring prey.

It will not here be necessary to enter upon a discussion concerning the various forms of tubular nests that are constructed; but a few words respecting the probable origin of the door-making habit may prove of interest.

In the first place, it is important to note that the remarkable instinct to close the aperture of a tubular nest with a movable lid is possessed by spiders belonging to two groups. These are the *Lycosidæ*, or wolf-spiders, of which the South European *Tarantula* is a historical example, and the gigantic *Aviculariidæ*, which have won such a bad name for their alleged bird-catching propensities. But although there is no direct genetic affinity between the species composing these two families, it is nevertheless highly interesting to note that they present a close parallelism in nest architecture. In both there are species which form no nest, others which construct a simple silken tube, and others which close the aperture of the tube with a hinged-door. Yet it is certain that the last-named instinct has been independently acquired in the two cases. Moreover, it is probable, as

will presently be explained, that in both cases it has been brought to its present state of perfection under stress of the same adverse conditions of life. As is well known, Mr. Moggridge long ago suggested that the instinct to construct the door may have arisen from the habit of closing the aperture of the tube in the winter and opening it again in the spring. This idea, in substance, has been adopted and further developed by Dr. McCook, who states, upon the authority of Mrs. Treat, that a North American species of wolf-spider (*Lycosa tigrina*) has acquired the instinct of sealing up the aperture of her nest during the breeding season of the Mason-wasps; for at this period these insects scour the country for spiders, in order that they may lay up a store of food for their young. When the wasps have disappeared with the close of their hunting and breeding season, the spiders venture again to remove the covering of their nests; but Mrs. Treat has made the further important observation, that some examples leave the covering attached at one point. Thus a genuine, though roughly-formed, trap-door nest is produced. In view of this circumstance, there cannot be much doubt that the permanent and highly-finished trap-door nest of the Russian *Lycosa opifex* has been similarly brought about, as M. Wagner, the discoverer of the species, has suggested, under the stress of the dire persecution from wasps to which spiders in general are subjected.

Being thus able to trace with some degree of certainty the steps by which the trap-door nest has been evolved in one group of spiders, namely, the *Lycosidæ*, we are justified in concluding, at all events until evidence to the contrary is forthcoming, that it has been evolved in the same way in the case of the *Avicularüidæ*—the trap-door spiders *par excellence*.

The primary influence, then, that has been at work in guiding the evolution of the architecture of the tunnel-making species, has apparently been that great necessity for the preservation of life, the avoidance of enemies. But if we turn to the other line, along which the web-building instinct has been developed, we find that the primary guiding influence has been that second great vital necessity, the acquisition of food.

As has been already stated, the origin of the webs which function as snares seems to be referable to a simple silken tent or tube, similar to that from which all the more or less complicated forms of tubular nests appear to have been developed. Perhaps the most rudimentary form of snare arose, as Dr. McCook has suggested, from the chance spinning of a few stray threads about the mouth of the tubular retreat; or, perhaps, an irregular network of threads spun around the aperture to interfere with the entry of such enemies as wasps, was the first step in the evolution of net-spinning; or even lines anchoring the tube securely in its site might have first served the purpose of catching prey. But, however this may be, it is clear, as Dr. Romanes[1] has pointed out, that "there is much potential service to which the power [of net-spinning] may be put with reference to the voracious habits of the animal." Taking this into consideration with the variation in structure presented by different species of spiders, it is not surprising that there are many modifications of the net. Sometimes it is a thick, closely-woven horizontal sheet, which is continuous at one extremity with a tubular retreat, as in the case of one of our commonest house-spiders, *Tegenaria*; or, as in the equally common *Amaurobius*, the net is less regular in shape and less thickly woven, but is still continuous, with a silk-lined hole, in which the spider lurks; or again, the web, as in *Pholcus* or *Theridium*, may be composed of an irregular mesh-work of interlacing threads, without any such tubular retreat as that constructed by *Tegenaria* or *Amaurobius*; or, lastly, it may be composed of radiating and concentric lines, like that of our garden spider, *Epeira*: and it seems to be generally admitted that this orbicular web of *Epeira* manifests the greatest perfection of instinct, and is therefore to be regarded as the highest form of this kind of spinning-work. Consequently, the question concerning the possible steps by which such a structure has been evolved cannot fail to be of interest.

In the first place, if all snares are traceable back to a common tubular origin, it may be taken for granted that those that are still associated with a tubular retreat are, *cæteris paribus*, of a more primitive type than those in which the tube has been abandoned. Furthermore, it may be confidently assumed that the habit of weaving the lines of the snare radially and concentrically in a definite and elaborate pattern, was preceded by the habit of arranging them irregularly and without order. Looked at from this point of view, the web of a *Tegenaria* or *Amaurobius* is a much less specialised structure than that of an *Epeira*. It may consequently be concluded that the complete orbicular snare of the latter animal, and of orb-weavers in general, has been derived from one which, like that of the tunnel-weavers, was composed of irregularly crossing threads, and was continuous at one extremity with a tubular domicile. Having arrived at this conclusion, we naturally appeal to nature for corroboration, and search for connecting links. Nor need we look far. For, taking first the tunnel-weavers, we find that a species of *Dictyna*, a spider nearly allied to our common *Amaurobius*, constructs a snare of which the threads are arranged radially and concentrically, but so roughly that the resemblance to the finished structure with which we are familiar in our garden-spiders is only remote. Nevertheless, one cannot avoid the conclusion that it represents an initial stage in the development of the perfect orb.

Turning, in the next place, to the orb-weavers, we naturally look out for snares constructed upon a more primitive plan than that which is typical of our English species of *Epeira*. But if there be any such in existence, we should reasonably expect, in accordance with our hypothesis, to find these simpler kinds associated with a tubular retreat. And our expectation would be justified by facts. For the large and handsome tropical genus *Nephilengys* spins a web which is structurally intermediate in character between that of *Epeira diademata* (our garden-spider) and that of the tunnel-weaver, *Dictyna*.[1] This web resembles that of *Tegenaria* and *Dictyna*, in consisting of a long silken tube, with an expanded funnel-shaped mouth opening directly upon an extended network of threads. But the latter, instead of being fashioned like that of the majority of tunnel-weavers, consists of a scanty mesh-work of lines arranged radially and concentrically with respect to the mouth of the funnel. In this particular it is similar to the net of our garden-spider, *Epeira*; but its area, instead of forming a complete circle, extends over only about one-third of this figure. The importance, however, of this distinction breaks down when the webs of other species of orb-weavers are taken into consideraton. For it is found that those of the Malaysian *Epeira beccarii*, as figured by Mr. Workman, and of the North American *Epeira labyrinthea* of Hentz, are completely circular, and yet the radial threads at the centre of the web spring from the mouth of a long silk tube, in which the spider lurks.

To all intents and purposes, therefore, there are not many links missing in the chain which starts with the web of a tunnel-weaver, like our house-spider *Tegenaria*, and terminates with that of our garden-spider *Epeira*. Furthermore, from the web of *Tegenaria* gradations may be traced backwards to the simple tubular retreat

[1] "Animal Intelligence," p. 208.

[1] I have to thank my friend Mr. H. A. Spencer for sketches of the web of a species of this spider, and also for a living example of the animal which he kindly brought to me from Durban, while acting as medical officer on board the s.s. *Mexican*. I was fortunate enough to keep this spider alive for several months, and was thus enabled by personal observation to satisfy myself of the accuracy of Mr. Spencer's representation of the web.

of some of the tunnel-weavers belonging to the family *Drassidæ*, which merely construct a web to serve as a nest during the breeding season.

But to strengthen the probability that such an evolution of webs has ever occurred, it is necessary to be able to show in what respects a snare composed of radiating and concentric lines may excel in efficacy the sheet-like web of a *Tegenaria* or the tangled mass of threads of a *Phalcus*.

Firstly, it seems clear that threads which radiate directly from the spot where the spider is stationed, must more rapidly and more certainly inform her of the position of a struggling insect than irregularly crossing threads, which must spread the vibration indiscriminately in all directions; and the advantage of there being as little delay as possible on the spider's part, between her perception of the vibration and her arrival at the spot, where it originates, will be readily understood by those who have observed powerful insects break loose from the web before being seized by the spider. Secondly, the object of the concentric lines is evidently to support the radii and to fill up the spaces between them. It may perhaps be urged, however, that these two ends would be apparently more satisfactorily attained if the inter-radial areas were filled in by a complete sheeting of web, or, at all events, by a larger number of threads than is used by an *Epeira* for this purpose. But it must be remembered, in the first place, that in proportion as the mesh of the web becomes closer, the whole structure is rendered more and more liable to be beaten down by the rain, or blown into shreds by the wind, unless its supports are correspondingly multiplied; and in the second place, that every thread of white silk that is added to the web, tends to make it more and more conspicuous, and so to convert it into a visible object, which will serve as a warning to wary flies, and as an attraction to marauding wasps. And these are the two ends which it is particularly the spider's interest to avoid, inasmuch as they are alike detrimental to its chances of life.

It is legitimate, therefore, to conclude that the principal, if not the sole factor that has guided the evolution of the orb-web, has been the advantage gained by a delicacy of construction, involving comparative invisibility. But the making for invisibility has been kept in check, and has not been permitted to go to the length of interfering with the efficacy of the web as a net, for which a closeness of mesh and strength of thread sufficient to intercept and hold insects is a vital necessity for the spider.

Seeing, then, the advantage of the radiating threads as rapid and sure transmitters of vibration, and the necessity for a net as inconspicuous and delicate, and yet as strong as possible, we are led to inquire if the method of filling up the inter-radial spaces with concentric lines is not calculated to afford the greatest possible support to the radii. This inquiry must, I think, be answered in the affirmative. For if, as is the case here, the threads be drawn from points on one radius to points on another, so as to make the two interior angles on either side of them equal, these threads are the shortest that can be made; and the shorter the threads, the less their elasticity, and the greater the support they supply to the radii. This fact alone has been, one would think, of sufficient importance to bring about the concentric arrangement of the supporting lines. But more than all this, it is also to be borne in mind that the shortest threads utilise the smallest quantity of silk, and take the shortest time to spin. So that, in constructing a net of radiating and concentric threads, it appears to me that an *Epeira* economises both time and silk, and in addition renders her snare as strong and as serviceable, and yet as delicate and invisible, as possible.

R. I. POCOCK.

NEW METRIC STANDARDS.

THE President of the Royal Society, with Sir John Evans, and the following members of the Council—Dr. A. A. Common, Mr. W. Crookes, Dr. A. R. Forsyth, Prof. H. Lamb, Prof. J. H. Poynting—visited the Standards Department of the Board of Trade on Thursday, the 21st inst., for the purpose of inspecting the new metric standards which have been recently deposited with the Department. The President and Council were received by Sir Courtenay Boyle, K.C.B., the Secretary of the Board of Trade, and Mr. H. J. Chaney, Superintendent.

Two new metric standards, of length and mass respectively (*des prototopes nationaux*), were delivered to the Board of Trade by the International Committee of Weights and Measures at Paris on September 28, 1889, and the third and final standard was received from the Committee in December last. All three standards are deposited at the Standards Office, 7, Old Palace Yard, Westminster, and are available for use in the verification of metric standards for the purposes of science.

The two standards received in 1889 include a "line" standard metre measure (*mètre-à-traits*) and a kilogramme weight. The standard received last year is an "end" standard metre (*mètre-à-bouts*). These three standards, together with other similar standards supplied to twenty-one different States, are, *inter alia*, the outcome of the results of the labours of the International Committee for more than twenty years; and Great Britain is the first country which has received all three of such standards.

The standards were verified at the Bureau International des Poids et Mesure (*Pavillon de Breteuil, Sèvres, près Paris*), which bureau was established under a Metric Convention, dated May 20, 1875, signed by twenty different High Contracting States, exclusive of Great Britain, who finally joined the Convention in September 1884. The Committee is a self-elected body, and is founded and maintained by common contribution from all countries who are parties to the Convention of 1875. The bureau of the Committee is required to be near Paris, and has been declared to be internationally neuter. The Committee was charged in 1875 with the construction, restoration, and verification of new metric standards (*des prototypes internationaux*) to replace the ancient standards of France (*mètre et kilogramme des archives*), and with the verification of copies of the new standards for all the contracting States. By such means the international accuracy of metric standards is now assured throughout the world.

The Committee, which includes thirteen members, undertakes also the verification of standards for scientific authorities or persons.

The Mètre.

The two metric standards above referred to are made of iridio-platinum, or an alloy of 90 per cent. of platinum and 10 per cent. of iridium. The metres are in transverse sections, nearly of the form of the letter X, known as the Tresca form, and selected as being not merely as the most economical (iridio-platinum being a costly metal), but as being less affected by heat, practically non-oxidisable, and well adapted for receiving finely engraved lines. This alloy appears to be of all substances the least likely to be affected by time or circumstance, and has been preferred for standards purposes to rock-crystal, gold, &c. The lines on the *mètre-à-traits* are fine, and are barely visible to the naked eye.

The actual relation of our prototype metre No. 16 is as follows:—

At 0° C.

$$\text{No. } 16 = 1 \text{ metre} - 0{\cdot}6\,\mu \pm 0{\cdot}1\,\mu \text{ at } 0^\circ \text{ C.}$$

Here μ means one micron, or one-thousandth of a millimetre (or nearly 0·00004 inch), so that metre 16 may

be said to have been verified with an accuracy of one part in a million.

The certificate of the verification of the end standard, or *mètre-à-bout* (étalon No. 6), will not be issued by the Committee until their general conference in September next; but this standard has been verified also with great accuracy, with a probable error of $\pm 0{\cdot}3\,\mu$. In the verification of the end standard (*mètre-à-bout*) MM. Cornu and Benôit have introduced a method of reflection, by means of which it is unnecessary to bring the ends of the metre bar into contact with any touching surfaces, and thus the measuring ends of the bar may be carefully preserved and used. Only Austro-Hungary, Germany, Great Britain, and Russia have at present applied to the International Committee to be supplied with *end* standard metres.

Experiments with reference to light-wave analysis, which have been carried out under the directions of the International Committee by Dr. Michelson during 1893, with the view to the discovery of a radiation of light of sufficient homogeneity to serve as an ultimate standard of length, appear to show that it is possible within certain limits to reproduce the length of the metre by reference to such physical constant.

The Kilogramme.

The unit of mass of the kilogramme is determined by a piece of iridio-platinum in the form of a cylinder, the height and diameter of which are equal (thirty-nine millimetres). The kilogramme, No. 18, supplied to Great Britain has no distinguishing marks, and is highly polished. On analysis it showed very faint traces of ruthenium, rhodium, and iron. Its volume was found to be at 0° C.

Prototype 18 = 46·414 millilitres,

corresponding to a density of—

21·5454.

After its final adjustment it was found to be *in vacuo* at 0° C.

Prototype 18 = 1 kg. + 0·070 ± 0·002 milligramme.

So that it may be said that the kilogramme (kg.) has been verified with a probable accuracy of 0·002 parts in a million.

NOTES.

THE Committee of the Athenæum Club, acting under the Rule which provides for the annual election of persons "of distinguished eminence in science, literature, the arts, or for public services," have admitted to membership Prof. Bayley Balfour, F.R.S., and Sir W. H. White, K.C.B., F.R.S.

DR. F. J. LAUTH, the eminent Egyptologist, died at Munich on the 11th inst., at the age of seventy-three. He was Honorary Professor of Egyptology at the University of Munich, and Keeper of the Egyptian Collections. His writings on the antiquities of Egypt are numerous and important.

WE regret to announce the death of Prof. Heinrich Wild, of St. Petersburg. He was a Swiss by birth, and his work in magnetism and optics, as well as the magnetometer, polaristrobometer, and other instruments devised by him, are well known to students of physics.

IT is reported from Athens that the architect who has examined a number of the ancient monuments in Athens, states that the majority of them, and particularly the Parthenon and the Temple of Theseus, are in a dangerous state. The work of rendering them secure would cost a million drachmas. The Archæological Society intends to make an appeal to all countries for a portion of the money required to restore these wonderful monuments to a sound condition.

GENERAL ANNENKOFF, constructor of the Russian Central Asian Railway, has been appointed one of the vice-presidents of the International Congress of Geography to be held in London in July next. Russia will further be represented on that occasion by nine or ten other well-known men, including Senator Semenoff (vice-president of the Imperial Russian Geographical Society), M. Grigorieff (secretary of the same society), and Baron Wrangel (director of the Imperial Lyceum).

A REUTER telegram from St. Petersburg reports that a scientific expedition, organised by the French Minister of Public Works, has just arrived at Samarcand. The head of the expedition is M. Jean Chaffanjon, who has previously made a journey in South America, and he is accompanied by two naturalists, MM. Henri Mangine and Louis Gay. From Samarcand the expedition will proceed to Tashkend, and after completing all the necessary preparations there, will start on a journey of exploration in Tibet and other countries.

WE are informed by the trustees of the Australian Museum, Sydney, that Dr. E. P. Ramsay, after twenty years' service as Curator of this Museum, has retired, owing to ill-health. Dr. Ramsay's official connection with the Museum as Curator ceased from December 31, 1894. The trustees have appointed as his successor Mr. R. Etheridge, jun., formerly of the British Museum, and lately Palæontologist to this Museum, and to the Department of Mines of New South Wales, and who has on several occasions temporarily acted as Curator. Mr. Etheridge has entered on the duties of Curator.

DR. A. R. WILLIS will commence a course of six lectures to working men at the Museum of Practical Geology, Jermyn Street, on Monday, March 4. The subject of the course is "Heat Engines."

THE weather over these islands has been comparatively mild during the past week, and the higher temperatures which set in at the end of the prolonged frost were maintained for some days; subsequently there was a slight return of cold, with high barometric pressure, accompanied by strong north-easterly winds, and snow showers in various places. Frost occurred on Sunday and following nights, the lowest shade temperatures being 22° in the central parts of Ireland, while in the south-eastern and midland portions of England the readings were several degrees below the freezing point.

AT a recent meeting of the Vienna Academy of Sciences, the President announced that the late Herr Joseph Treith, director of the First Austrian Savings Bank, had bequeathed the whole of his considerable fortune to the Academy for the purpose of the advancement of science. The grants are to be apportioned by a committee of five, three of whom are to be appointed by the Academy, and two by the Minister of Education, the Academy to decide all doubtful questions. The branches of science to be encouraged are those for which there is no other official provision made. Among the subjects suggested are the physical structure of the earth and of the heavenly bodies. The income is to be divided every year into several grants, but if some great enterprise is to be undertaken, it shall be permitted to let the funds accumulate for not more than three years. The extension of higher instruction among all classes fitted for it by education, the strengthening of moral character, the advancement of technical education, the simplification of medical practice, and the furtherance of the material prosperity of the human race by invention and discovery, are the guiding principles indicated by the donor for the administration of his generous gift.

AT the last meeting of the Société Française de Navigation Aërienne, M. de Fonvielle gave an account of a paper by M. Andrée, the chief engineer of the Swedish Patent Office, read

on the 14th inst. before the Stockholm Academy of Sciences. In that paper the Swedish aëronaut described a scheme to go to the North Pole in a balloon, and, to carry out his plans, he asked for a sum equivalent to about £7220. Although M. Fonvielle opposed a similar scheme put forward about seven years ago by two of his countrymen, he expressed himself favourable to the new undertaking, and his opinion seemed to have been shared by the Society. M. Andrée has already executed a number of ascents in very difficult circumstances. He is well acquainted with all the peculiarities of Arctic climates, having been one of the meteorologists of the Swedish 1882–83 expedition for observing the transit of Venus from Cape Thorsden. He hopes to start from this station in the month of July, 1896, as it appears that there are no great variations of temperature at that time of year. The balloon is to contain 186,000 cubic feet of gas, and the inflation process is to be carried out at Cape Thorsden by means of compressed hydrogen.

THE Select Committee of the House of Commons appointed to inquire into the existing systems of weights and measures in this country had a meeting on Tuesday, under the presidency of Sir Henry Roscoe. Evidence was given by Mr. H. J. Chaney, Superintendent of the Standards Department of the Board of Trade, who described the system under which the verification of legal standards is carried on at the Board of Trade by experts appointed for the purpose, and also gave an account of the different systems of weights and measures now in use in the United Kingdom. He stated that the Imperial and the metric systems were the only ones with which the Department had to do in England, but there were other local customary weights and measures in use. There were many weights and measures in use which were not legally recognised. Among these he mentioned the carat, the boll (used in Scotland), the ell, the coomb (used for measuring corn), the Winchester bushel, the butchers' stone of 8 lb., the miners' dish (used for weighing ore in Derbyshire), and the gauge (used in measuring plates) as examples of weights and measures which were not recognised by law. A number of anomalies which formerly existed—*e.g.* a ton of stone being different from a ton of other materials, &c.—had disappeared to a great extent under the operation of the Weights and Measures Acts of 1878 and 1889. The Scotch and Irish mile were still locally recognised, but for all statutory purposes a mile was 1760 yards. Practically the only two countries of any importance in Europe in which the metric system was not adopted were Great Britain and Russia. In Germany, Austria, France, Italy, Spain, and Portugal the metric system was the only system in use.

DURING recent years the advantages of work at biological stations have been recognised at various Universities. The Indiana University has lately shown its appreciation of the need for such research by deciding upon the establishment of an inland biological station on one of the lakes of Northern Indiana, probably Maxinkuckee. To begin with, the main object of the Station will be the study of variation. For this purpose it was thought that a small lake would present a limited, well circumscribed locality, within which the differences of environmental influences would be reduced to a minimum. The study will consist in the determination of the extent of variation in the non-migratory vertebrates, the kind of variation whether continuous or discontinuous, the quantitative variation, and the direction of variation. In this way it is hoped to survey a base line which can be utilised in studying the variation of the same species throughout their distribution. This study should be carried on for a series of years, or at least be repeated at definite intervals to determine the annual or periodic variation from the mean. A comparison of this variation in the same animals in other similarly limited and well-circumscribed areas, and the correlation of the variation of a number of species in these areas, will demonstrate the influence of the changed environment, and will be a simple, inexpensive substitute for much expensive experimental work. In connection with this study of the developed forms the variation in the development itself will receive attention; for instance, the variation in segmentation, the frequency of such variation, and the relation of such variation in the development to the variation in the adult, and the mechanical causes affecting variation. Admirable courses of instruction have been drawn up by Prof. Carl H. Eigenmann, the Director of the Station, to lead to the special investigations, and there is every indication that useful work will be accomplished.

DR. A. PETER gives, in the *Nachrichten von der Königlichen Gesellschaft der Wissenschaften zu Göttingen*, the results of a second series of cultural experiments with dormant seeds, taken from various depths in the soil of woodlands or forest. The forest in question of the present day is the site of villages and cultivation that disappeared several centuries ago; and some of the samples were taken from dense forest, 100 to 150 years old, under the shade of which there has been no surface vegetation for years. The principal point to investigate was the probable existence of seeds of cornfield weeds still possessing the power of germinating and developing into reproductive plants. Dr. Peters succeeded in raising a large number of plants belonging to about fifty different species, including some that are essentially weeds of cultivation; and he believes he has good grounds for supposing that the buried seeds of many pasture plants and cornfield weeds retain the vitality much more than half a century; that is, under the conditions he describes.

THE hundreds of Gulls that have lately come up the Thames in search of food seem only matched by a remarkable invasion of the north and north-east coasts, by the Little Auk (*Mergulus alle*) during January. Writing in the *Zoologist*, Mr. J. E. Harting says that on the 21st of that month, great numbers were observed passing south, both at sea and along the coast, and many were cast ashore in a helpless condition, exhausted in their attempts to withstand the stormy weather which has recently prevailed. In the neighbourhood of Redcar, as many as two hundred and fifty of these little birds have been counted; at Scarborough they were also numerous, and on the Norfolk coast one hundred and twenty have been captured. Another result of the severe weather and snow during the third week in January, was that the Grouse in Yorkshire left the moors in packs, and migrated to the lower grounds in search of food and shelter. It is pointed out that an exodus of this kind is of extremely rare occurrence; the last one being during the severe winter of 1886.

IN the *Meteorologische Zeitschrift* for December last, Prof. G. Hellmann gives a very interesting account of the invention of the barometer which has now been in use 250 years. Torricelli, who died at the early age of thirty-nine years, was too busily engaged in mathematical studies to publish an account of his discovery, but on June 11, 1644, he wrote a description of it to his friend Ricci. This letter, and Ricci's objections to the experiment, were published in 1663 by C. Dati, a friend of Torricelli's, and as this work is now exceedingly scarce, Prof. Hellmann has reprinted the correspondence, in the original Italian, in the above-mentioned journal. Some of the paragraphs are noteworthy, especially those in which Torricelli states that it was not merely a question of producing a vacuum, but of making an instrument which would indicate the changes of the atmosphere. The first continuous barometrical observations appear to have been made in France. In England they were first taken by Robert Boyle, about the year 1659, to whom we owe the invention of the word "barometer."

SOME time ago we gave an account of the considerable extension of the ultra-violet photographic spectrum obtained by Dr. Victor Schumann, of Leipzig, by eliminating the air between the source and the sensitive plate, which was found to exert a strong absorption upon the rays of shortest wave-length. This work has been carried on since with great success. At a recent meeting of the Vienna Academy, Dr. Schumann announced that he had improved his plates and his "vacuum spectrograph" so as to obtain results in a few minutes which used to take as many hours. The hydrogen spectrum shows a further lengthening, and the spectra of cobalt, iron, aluminium, zinc, and cadmium have also been considerably extended beyond 170 $\mu\mu$. This limit, although far beyond the ordinary limits of the photographic spectrum, was due to a residue of air and electrode vapour. The absorptive effect of air upon the most refrangible rays was traced down to thicknesses below 0·01 mm. Hydrogen also shows a strong absorption for these extreme rays, especially if insufficiently dried.

HERR K. MACK, working in the Hohenheim Physical Institute, has succeeded in demonstrating the occurrence of double refraction of electric waves in wood. That electric waves, unlike light waves, are capable of penetrating wood, was already found by Hertz. "It is not without surprise," he says in his classical work on the "Propagation of Electric Force," "that one sees the sparks appear inside a closed room." But the fact that waves of electric force are transmitted in a different manner accordingly as they vibrate across or along the fibre of the wood, has only just been proved by Herr Mack, who gives a full description of his method in the current number of *Wiedemann's Annalen*. It is well known that two Nicoll prisms transmit no light when their principal planes are crossed, but that light may be made to appear by inserting a doubly-refracting substance between them. For the Nicoll prisms substitute Hertzian concave mirrors with their focal lines crossed, and, instead of the tourmaline or other doubly-refracting substance, insert a plate of wood 10 inches thick, with its fibre at 45° to each of the focal lines, and you have Mack's apparatus. The sparks, which are extinguished on crossing the two focal lines, reappear on inserting the wood in the manner indicated. This striking experiment forms another important link in the chain connecting the domain of light with that of electricity.

IN an admirable paper on the after-shocks of earthquakes (*Journal* of the College of Science, Imperial University of Japan, vol. vii. part ii.), Mr. F. Omori has attacked a somewhat neglected branch of seismology. In three recent Japanese earthquakes, those of Kumamoto in 1889, Mino-Owari in 1891, and Kagoshima in 1893, the after-shocks have been carefully recorded, and are here specially studied from the frequency point of view. Numerous tables are given, and also many curves showing the way in which the number of after-shocks varies with the time at different places. When their inequalities are smoothed away, these curves differ little from rectangular hyperbolas. At the same time, they show periodic fluctuations in the decrease of frequency of after-shocks. Besides the diurnal and annual fluctuations, six different periods have been ascertained, whose lengths range from a few hours to several months. In the case of the great Mino-Owari earthquake of 1891, the after-shocks were most numerous some distance to the south of the principal epicentral tract, which lay in the Neo valley. They also occurred more frequently along four axial lines, radiating from the vicinity of Koori, than in the neighbouring districts. Mr. Omori suggests that the principal earthquake was caused by the formation of some great fractures beneath the Neo valley, and that the axial lines indicate the positions of four weaker or deeper fractures, along which the crust is not yet in the way of steadily settling into equilibrium.

IN a paper recently published (*Journal of Geology*, May-June 1894; *Johns Hopkins University Circular*, January 1895), Prof. W. K. Brooks discusses from the zoological point of view a problem familiar to the geologist—the sudden appearance in the Lower Cambrian of a rich fauna in which most of the great classes of animals are represented by unmistakable forms. His conclusion is that early Cambrian times and those immediately preceding them formed a period of rapid modification induced by the first colonisation of the sea-bottom. His arguments may be briefly summarised thus:—Embryology indicates simple pelagic forms, as the ancestors of all the great animal stems. The existing pelagic fauna consists in part of small and primitive forms, and in part of the specialised descendants of shore or bottom forms. The fact that the latter are almost exclusively carnivorous indicates the enormous wealth of plant-life, mostly of minute forms, on which ultimately the existence of all the fauna depends, and shows the extremely favourable character of the conditions of pelagic life to simple organisms. The supply of these simple organisms is inexhaustible, and on them the bottom-fauna also depends for food. It is suggested that the evolution of all the main stems of animal life took place at the surface of the ocean, but that when their descendants had colonised the bottom the crowding that soon ensued there led to fierce competition, especially between nearly related forms, and to the specialisation of the types already established, but not the production of new types. The development of hard skeletons was an early result of these conditions. Geologists will certainly find many points to criticise in Prof. Brooks's suggestions, but they constitute an important addition to the discussion of faunal origins.

ONE of the many botanic stations the advancement of which has been promoted by the Director of the Royal Gardens at Kew, is that at Aburi on the Gold Coast. A few interesting facts referring to the establishment and present condition of this station are given in the *Kew Bulletin* for January, from which the following information has been gathered. The site is in the hills, at an elevation of about 1400 feet, overlooking the sea-board, near Accra and Pram Pram. In addition to its suitability for the growth of economic plants, Aburi is a valuable resort for European invalids. The locality has been greatly improved of late years, and it promises to become the centre of activity for many cultural industries started by the Botanic Station. During the winter of 1893–94 Mr. William Crowther, the curator (appointed in 1890), was deputed to visit the West Indies "to observe the system pursued there in the cultivation of economic plants, and to bring back such useful seeds and plants as might with advantage be introduced to the Gold Coast." Mr. Crowther very successfully carried out the object of his mission, and published a detailed report. Since then the work of the Aburi Station has made excellent progress. The inception, as well as the actual work, so far accomplished in botanical enterprise at the Gold Coast, is entirely due to the Governor, Sir W. B. Griffith. He has given warm and consistent support to the station, and personally encouraged in every way the efforts of the curator.

THE *Forschungsberichte* (Theil 3, 1895) of the biological station at Plön, recently published, contains a number of interesting papers on the flora and fauna and on the biological phenomena of the lakes adjoining the station. Among the contents may be mentioned the copious reports on the flora by Drs. Klebahn and Lemmermann, the faunistic contributions of Dr. Zacharias, and the memoirs of Drs. Zacharias and Strodtmann on the Plankton of the lakes. The investigation of the movements, periodicity, and changing quantity of floating organisms in inland waters can be pursued with such ease and completeness, as compared with marine phenomena,

that biologists may look forward to the early achievement of valuable results by Dr. Zacharias and his assistants. The present report goes far to justify this expectation.

THE history of the Royal Microscopical Society, as told by Mr. A. D. Michael in his presidential address last month, is contained in the February *Journal* of the Society.

A BOOK of gummed labels, for the chemical laboratory, having the names of 750 special reagents, &c., printed upon them, has been compiled by Mr. W. H. Symons, and published by Messrs. A. Gallenkamp and Co.

WE are always glad to see the Reports of the Natural Science Societies of our Public Schools. The twenty-fifth annual report of the Wellington College Society has just come to hand, and the abstracts of the lectures delivered under the auspices of the Society, as well as the records of observations in various branches of science, show that excellent work is being done in creating and fostering interest in natural knowledge.

MR. H. WARINGTON SMYTH'S "Notes of a Journey on the Upper Mekong, Siam," read before the Royal Geographical Society just a year ago, have been published in a handy and attractive form, for the Society, by Mr. John Murray. Siamese and Laos life are vividly described in the volume, and interesting information is given with regard to the geographical and general features of the country traversed.

THE Society for the Protection of Birds was called into existence to protest against the slaughter of birds for decorative purposes. It now numbers more than eleven thousand members, and the fourth annual report shows that it plays an important part in preventing the extermination of our rarer species of birds. Owing to the Society's efforts, that remnant of primitive ornamentation—the bird-wearing fashion—is on the decline. The Bill passed last July, to amend the Wild Birds' Protection Act of 1880, is given at length in an appendix to the report.

A HANDY work of reference, occupying an intermediate position between a mere school dictionary and a bulky lexicon, is Ogilvie's "Student's English Dictionary," a new edition of which, edited by Dr. C. Annandale, has been published by Messrs. Blackie and Son. The new issue has been so greatly changed and augmented, that it is practically a fresh work. A large number of scientific and technical terms, many of them recently introduced, as well as thousands of other words, have been added. The woodcut illustrations have been more than doubled, there being now nearly eight hundred of them. Experience has taught us that the "Students' Dictionary" rarely disappoints the inquirer; in its improved and enlarged form, it will be even more useful.

MESSRS. MACMILLAN AND CO. will shortly publish an important work on "Meteorology," by Mr. T. Russell. The book has for its main object the explanation of the use of weather-maps for the purpose of making forecasts. The various forms of meteorological instruments are described, and a general view is taken of all knowledge connected with the science of meteorology, and of interest in relation to weather changes. To a large extent, the volume refers to weather prediction in the United States, and to the use of weather-maps in the prediction of floods along the lower Ohio and Mississippi Rivers. It will, however, also appeal to European meteorologists, as well as assist in the development of scientific weather observation and prediction. Another work which will very soon be published by the same firm, is a translation of the late Prof. A. de Quatrefages' "Les Pygmées." This volume, which is the second in the Anthropological Series, has been translated by the editor of the series, Prof. F. Starr, of the University of Chicago.

THE atomic weight of tungsten has been subjected to a careful revision by Prof. E. F. Smith, of the Pennsylvania University, and the specific heat of the pure metal again determined. Two independent series of atomic weight determinations have been carried out, in which Prof. Smith has been assisted, respectively, by Miss M. E. Pennington and Mr. E. D. Desi, and accounts of the work are contributed to the current issue of the *Zeitschrift für Anorganische Chemie*. In the first series the method employed consisted in the reduction of pure tungstic acid to metal in a stream of pure hydrogen, and then determining the amount of oxygen absorbed by the metal upon conversion of the latter into tungstic anhydride by ignition in contact with the air. The mean value of the atomic weight derived from nine such determinations, taking oxygen as 16, is 184·92. The highest and lowest values obtained differed by only 0·02 from this mean value. The second series of determinations were based upon the estimation of the amount of water produced during the reduction of tungstic acid by hydrogen. Exceptional precautions were taken with the purification of the latter, in order to exclude error from this source. The mean of six experiments affords the value 184·70 for the atomic weight of tungsten, the greatest difference between the individual values being only 0·07. The slight difference of 0·2 between the results derived from the two methods of work is probably to be ascribed partly to the difference in the methods, and partly to the different personal factors involved. The mean of the two series, 184·8, may therefore be taken as representing a close approximation to the true atomic weight of tungsten. This value is considerably higher than the currently accepted one, 184·02, the number afforded by Clarke and Becker's recalculation of the experimental results of older determinations. The increase is in all probability due to the great pains which have been taken to remove the last traces of the lighter molybdenum from the tungstic acid employed, a task which is particularly difficult, and which most likely has never previously been so completely achieved.

THE specific heat of the pure tungsten obtained during the course of the atomic weight determinations has been ascertained by Prof. Smith in conjunction with Mr. Grodspeed The method adopted was that described by Joly in 1886, involving the use of the "gravimetric calorimeter." The final mean value arrived at for the specific heat of tungsten 0·0338, a result closely agreeing with former determinations o this constant. The atomic heat obtained by multiplying the new value for the atomic weight by this number expressing the specific heat is 6·25, a value in fairly close accordance with that usually accepted as representing the constant of Dulong and Petit for the truly metallic elements.

The additions to the Zoological Society's Gardens during the past week include a Lion (*Felis leo*, ♂) from India, presented by Her Majesty the Queen; a Black-striped Wallaby (*Halmaturus dorsalis*, ♂) from New South Wales, presented by Miss H. W. Howes; a Hairy-rumped Agouti (*Dasyprocta prymnolopha* from Guiana, presented by Miss W. B. Jackson; a Rose-ate Cockatoo (*Cacatua roseicopilla*) from Australia, presente by Mr. A. Reynart; four Triangular-spotted Pigeons (*Columba guinea*), two spotted Eagle Owls (*Bubo maculosa*) from South Africa, presented by Mr. J. E. Matcham; a Fieldfare (*Turdus pilaris*) British, presented by Mr. Gervase F. Mathew; two Lions (*Felis leo*, ♂ ♀) from India, deposited; an Eland (*Oreas canna*, ♀), two Collared Fruit Bats (*Cynonycteris collaris*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ORIGIN OF THE LUNAR FORMATIONS.—The experiments by which Scrope attempted to reproduce the characteristic features of the moon's surface have been repeated with slight modifications by M. Stanislas Meunier, and the results which he has obtained are certainly very suggestive, if, indeed, they do not furnish the key to the origin of the various formations which the moon presents to us. (*Comptes rendus*, January 28.) Plaster is mixed with water in which a little glue has been dissolved to prevent too rapid setting, and the mixture is heated in a frying-pan over a gas-burner until ebullition commences; the gas is suddenly turned off at an opportune moment, and the mass is left to cool undisturbed. Experimenting in this way, and by varying the consistency of the paste, M. Meunier has obtained many features besides the intermingling circular cavities produced by Scrope. The central peaks which are so frequently noticed in lunar craters are reproduced perfectly, being formed at exactly the same time as the circular borders, and even resembling their lunar prototypes in being generally somewhat lower than the edges of the craters. Further, the artificial craters tend to form in groups of two or three, or even more, and sometimes one ring will envelope several; some parts may be covered with cavities, with or without central peaks, and relatively large smooth areas at once recall the lunar "seas." If the experiment be carried on until nearly the whole of the water is evaporated, fissures also make their appearance.

By covering the paste with fine grey sand at the moment it begins to boil, the results are said to be still more striking, and better adapted for photography.

M. Meunier expresses the opinion that the moon has failed to pass through all the planetary stages, in consequence of the original relative scarcity of fluids, and he believes this conception to be confirmed to some extent by another modification of the experiment, in which the paste is covered with a rather thick layer of sand, representing the rocks forming the earth's epidermis; the "volcanic" manifestations then change character, and more nearly approach terrestrial types.

γ CASSIOPEIÆ.—This star has always possessed a special interest to spectroscopic observers since the discovery of bright lines in its spectrum by Secchi. Continued observations seemed to suggest a periodicity in the visibility of the bright lines, but this question can now be attacked more completely by the photographic method. Fifty-three photographs, extending over a period of six years, have been taken at South Kensington, and a first examination of the negatives has led to several important conclusions (*Roy. Soc. Proc.* vol. lvii. p. 173). The lines of hydrogen were constantly bright in the period covered by the photographs, and other bright lines were also seen in all good photographs. Further, the lines of hydrogen are double in all the photographs taken with sufficient dispersion, and the distance between the components is constant within the limits of error in measurement. Other conclusions are that the bright lines of hydrogen are superposed on broad dark bands, and that there are also other ill-defined dark lines in various parts of the spectrum; these dark lines correspond very closely with the lines seen in the spectra of ζ Orionis and Bellatrix. "This at once contradicts Prof. Scheiner's recent statement that he does not believe it possible that dark lines can exist in the spectrum." Dark lines have also been observed and photographed by Keeler.

It will be seen that the spectrum presents numerous peculiarities, and an explanation of the physical condition of the star or stars which produce the different appearances is by no means simple.

THE IDENTITY OF DENNING'S AND BRORSEN'S COMETS.—It was pointed out in the *Astronomische Nachrichten*, No. 3271, that the orbits of the comet 1894 I (Denning), and Brorsen's comet, intersect in heliocentric longitude 285°, and that early in 1881 the two objects must have been close to one another near the point of intersection (see NATURE, January 24, p. 302). The elements used for the comparison were, in the case of Denning's comet, due to M. Schulhof. This computor gives new elements for the comet, in *Astr. Nachr.* No. 3276, and expresses an opinion upon the suggested connection. He thinks that the elements compared, with the exception of inclination, certainly present some points of resemblance. More important, perhaps, is the fact that the point of intersection of the two orbits is nearly their point of nearest approach to the orbit of Jupiter. Applying M. Tisserand's criterion for the connection between two orbits, the value 0·47 was found for Brorsen's comet, and 0·50 for Denning's. It is therefore concluded that the two comets formed at one time a single body, and that after their separation their orbits were more and more modified by Jupiter.

THE ANTITOXIC SERUM TREATMENT OF DIPHTHERIA.[1]

II.

The Treatment.

ASSUMING now that the antitoxic serum is available, how is it to be used? It has been strongly recommended that it should be used not only as a curative or direct therapeutic agent, but that it should also be used as a prophylactic—that is, as a protective agent against possible infection, especially during those periods when diphtheria is rife. It is almost too soon to consider this prophylactic property of antitoxic serum, as for some time to come the energy of those engaged in the preparation and use of this serum must be directed towards obtaining a sufficient supply for the treatment of cases of developed diphtheria.

Results of this Method of Treatment.

It may be well to consider what have been the results obtained up to the present, and for this purpose the statistical method will probably carry most conviction, especially if it is possible to give full and accurate detail; and now that these statistics have been criticised not only by those who have used this treatment, but also by those who oppose it because it runs counter to their feelings and ideas, they are every day more and more trustworthy, much fuller, and more valuable.

It is first necessary to determine the average case mortality in diphtheria for some considerable period before the antitoxic treatment was introduced; then to see what has been the lowest case mortality during an equal and similar period for which we have any statistics; and lastly, to compare these with the case mortality of the period during which the antitoxic serum has been used.

In Table I. are given the mean annual death rates from diphtheria per million living in England and Wales and in London, in four periods of three years each.

TABLE I.

	1881-3	1884-6	1887-9	1890-2
England and Wales ...	144	166	173	192
London	213	227	315	377

Dr. Sykes gives the following statistics:—During the year 1892 there were 1962 deaths from diphtheria in London, whilst in 1893 there were 3265, or nearly twice as many deaths.

Now let us see what has been the case mortality. Statistics after correction give the following results. During 1893 there were 13,694 cases of diphtheria notified in London. The mortality amongst these cases was 3195 (*Lancet* statistics corrected), or 23·3 per cent.

Table II. gives further information, and enables us to see what is the diphtheria case mortality in large well-found hospitals.

TABLE II.—*Metropolitan Asylums Board: Admissions and Case Mortality, Diphtheria*, 1888–93.

Year.	No. of admissions.	No. of deaths.	Percentage of case mortality.
1888	99	46	46·4
1889	722	275	38·0
1890	942	316	33·5
1891	1312	397	30·2
1892	2009	583	29·0
1893	2848	865	30·3

Note.—Diphtheria cases have only been admitted into the Hospitals since October 23, 1888.

In Table III. are given statistics dealing with the diphtheria case mortality where the serum treatment has been used. Wherever possible, the case mortality over a considerable period is given in the last column of the table, for purposes of comparison.

[1] A lecture delivered at the Royal Institution, on Friday, February 8 by Dr. G. Sims Woodhead. (Continued from page 406.)

TABLE III.

		Number of cases.	Number of deaths.	Percentage of mortality.	Percentage of previous mortality.
GERMANY, AUSTRIA, HOLLAND :—					
Kossel (up to May 1894)	Berlin	233	54	23·0	34·7
Kossel (March 15–December 1, 1894)	,,	117	13	11·1	
Bokai	Buda-Pesth	35	5	14·2	53·8
Heubner	Berlin	96	37	38·5	62·5
Katz	,,	128	17	13·2	38·9
*Aronson	,, &c.	255	31	12·1	32·5–41·7
Körte	,,	121	40	33·1	53·8
Ranke	Munich	19	4	21·0	49·2
*Weibgen	Berlin	65	18	28·0	40·0
Börger	Greifswald	30	2	6·6	20
Kuntzen	Oscher leben	25	3	12	
Hager		25	1	4	
Möller	Magdeburg	76		39·6	55·6
Sonnenburg ...	Berlin	107	22	20·6	27·6
*Bagnisky (quoted by Virchow) ...	,,	303		13·2	47 8
*Hahn	,,	205	49	24	40 0
Wiederhofer ...	Vienna	100	24	24	52·6
	Trieste	252	45	17·8	43·8
Schüler		32	none	0·0	
Strahlmann ...		100	,,	0·0	
Rumpf	Hamburg	26		8·0	12·0
Blumenfeld ...	Austria	50	2	4·0	38·0
Heim	Vienna	27	6	22·2	52 5
Gnändinger ...	,,	27	11	40·7	
Monti	,,	25	1	4	
Unterholzner ...	,,	31	8	25·8	66 6
Ganghofner ...	Prague	110	14	12 7	49
Other observers		39	4	10·2	
FRANCE, ITALY, BELGIUM, SWITZERLAND :—					
Roux, Martin, and Chaillou ...	Paris	448	109	24·5	51·7
Moizard	,,	231	34	14·7	50·0 [1]
Lebreton... ...	,,	242	28	11·5	
Rabot	Lyons	47	16	34·0	50·0
Mya	Florence	17	2	11·7	
Massei	Naples	4	none	0 0	
Charon	Belgium	13	4	30·7	
Seitz	Constance	27	1	3·7	
AMERICA :—					
White	New York	32	8	25·0	42·7
Muehleck ...	Philadelphia	2	0		Two not treated died
Welch	Baltimore	5	1	20	
Catlin		1	0		
GREAT BRITAIN :—					
Cases reported in the *Lancet* and *British Medical Journal* ...		123	22	17	Average for London 23·3
Washbourn, Goodall, and Card ...		72	14	19·4	Average for Hospital 38·8

It is objected, however, that general statistics of this kind are of comparatively little value unless the age of the patient treated is given. In order to determine the foundation upon which this certainly very legitimate objection is based, I have taken four series of cases as reported, and have placed them side by side. The percentages of deaths at certain ages in the London Asylums Board hospitals before the serum treatment are given in Table IV., the percentages of deaths of four observers who have used the serum, in Tables V. and VI.

[1] There is probably some overlapping, especially in the Berlin figures. This fact must be taken into account in dealing with this table as a whole.

TABLE IV.—*Showing the Mortality at Various Ages from Diphtheria admitted into the Metropolitan Asylums Board's Hospitals in the years* 1888–93.

Ages.	Cases admitted.	Died.	Mortality per cent.
Under 1	146	102	69·9
1 to 2	447	291	65·1
2 to 3	639	388	60·7
3 to 4	826	416	50·4
4 to 5	913	400	43·8
Totals under 5 ...	2971	1597	53·8
5 to 10...	2462	705	28·6
10 to 15...	885	93	10·5

TABLE V.

Showing Mortality from Diphtheria at various Ages.

	Kossel.			Wiederhofer.			Goodall.			Total.		
	Treated.	Died.	Per cent.	Treated.	Died.	Per cent.	Treated.	Died.	Per cent.	Treated.	Died.	Per cent.
Under 1 year ...	3	1	33·3	8	5	62·5	4	1	25·0	15	7	46·6
1-2 years	4	0	0·0	24	9	37·5	10	2	20·0	38	11	28·9
2-3 ,, ...	18	2	11·1	20	7	35·0	7	1	14·3	45	10	22·2
3-4 ,, ...	14	3	21·4	14	0	0·0	9	3	33·3	37	6	16·2
4-5 ,, ...	20	3	15·5	16	3	18 7	10	5	50 0	46	11	23·9
Total under 5...	59	9	15·2	82	24	29·2	40	12	30·0	181	45	24·3
5-10 years ...	45	3	6·6	15	0	0·0	22	2	9·1	82	5	6·0
10-15 ,, ...	13[1]	1	7·7	3	0	0·0	10	0	0 0	26	1	3·8
Grand totals ...	117	13	11·1	100	24	24	72	14	19·4	289	51	17·6

[1] None of these were more than 13 years of age.

TABLE VI.

Baginsky (quoted by Virchow).

	Without serum treatment.			With serum treatment.		
	Treated.	Died.	Per cent.	Treated.	Died.	Per cent.
0–2 years...	33	23	69·7	34	8	23·5
2–4 ,, ...	56	37	66·1	82	16	19·5
4–6 ,, ...	50	27	54·0	81	7	8·6
6–8 ,, ...	44	15	34·1	46	5	10·9
8–10 ,, ...	24	7	29·2	30	3	10·0
10–12 ,, ...	14	1	7·1	18	0	0·0
12–14 ,, ...	9	0	0·0	12	1	8·3
	230	110	47·8	303	40	13·2

It is very important, however, that the period of the disease at which the treatment is commenced should be taken into account, for, as already indicated, experience has taught that the later the stages of the disease at which this serum is injected, the stronger must be the dose given. It is necessary, therefore, to separate the cases in which the treatment is commenced at an early period from those in which it is commenced only when the poison has had time to disorganise the tissues, and to render them incapable of reacting to the antitoxic serum.

The following table (VII.), given by Kossel, brings out the great importance of this element in keeping down the case mortality. In the first column is given the day of the illness on which antitoxic serum was first injected :—

TABLE VII.

Day of illness.	Treated.	Died.	Percentage.
I.	14	0	0·0
II.	30	1	3·3
III.	29	0	0 0
IV.	9	1	11·1
V.	11	2	18·1
VI.	6	3	50·0
VII.	5	2	40·0
VIII.	6	2	33·3
IX.	1	1	100·0
Unknown	6	1	16·6
	117	13	11·1

For statistical purposes, too, only those cases which have been bacteriologically examined and found to be due to the action of Loeffler's diphtheria bacillus should be accepted as being cases of true diphtheria. As most of the cases in which the diphtheria bacilli are absent run a much milder course, and are much more amenable to general treatment, and as many of these have been included under diphtheria in the old statistics, such elimination will necessarily make the record tell rather against the antitoxic serum treatment than in its favour.

From a somewhat extended experience (although condensed into a very short period of time) I am satisfied that this question of the Loeffler bacillus is most important, and that every case in which the serum is used should be bacteriologically examined.

It has been said, however, and said very truly, that statistics may be made to prove anything, and I have heard it said that the observation of a few cases of diphtheria under the antitoxic treatment is worth all the statistics that could be brought together for convincing a man of the value of the antitoxic serum treatment.

A distinguished physician, who has had charge of diphtheria wards for some time, informs me that the patients he sees now wear an entirely different aspect from those he saw before the serum treatment was adopted. Instead of being struck by the stupor, the pain, the difficulty of breathing, and the other distressing symptoms that so frequently manifest themselves during the course of this treacherous disease, he observes children with patches of membrane in the throat sitting up and playing with their toys. There is little of that distress of breathing, very little of the anxious look, and the wards altogether present a much more pleasant and genial appearance than he has ever before noticed. The other day I received a short note from another colleague, who has been going over the German hospitals to study this question, in view of taking out with him to the colonies a supply of antitoxic serum ; he also states that this difference in the appearance of the diphtheria wards has impressed him far more than any statistics he has yet come across.

The alleged Ill-effects of the Use of the Serum.

It has been said that most unfavourable symptoms have followed the exhibition of this serum. There can be no doubt of the fact ; but after a careful study of the cases reported, I am thoroughly convinced that a very large proportion of them, at any rate, are merely *post hoc*, and not *propter hoc*. There can be no doubt that a kind of nettle-rash makes its appearance during the course of treatment, and that this may be accompanied by pains in the joints. Both these conditions, however, are usually quite transient, and seldom give rise to permanent ill effects. Albuminuria has also been ascribed to this treatment; but any one who has had to deal with children not only suffering from diphtheria, but from any form of disease, and even from none at all, will bear witness that albuminuria in children is of comparatively frequent occurrence. It is not striking, therefore, that those who have hitherto paid little attention to this subject should, when they come to make a careful examination of children affected with diphtheria, find a considerable number of cases in which transient albuminuria is a prominent symptom. More than this, however, it has been my duty to examine a large number of cases in which diphtheria has proved fatal, and in these cases there were certain lesions in the kidney, so distinct and so frequently present, that in describing them I used to note simply "diphtheritic condition," and then describe in detail only those features in which the appearances differed from the type that I had in my mind. This will indicate to you that alterations in the internal organs, especially in the kidneys, such as would lead to marked interference with the performance of their proper functions, were present, and had been noted long before the antitoxic serum method of treatment came into use. I may give an example of what, under certain circumstances, might have been used as a powerful argument against the use of antitoxic serum. In the *Deutsche Medizinischer Wochenschrift* for December 20 of last year is reported a case of acute hæmorrhagic nephritis coming on after the use of Behring's curative serum. The patient recovered. But a similar case of acute hæmorrhagic nephritis in diphtheria, in which, however, the curative serum was not used, is reported in the same number of the same journal. The author of the second paper quotes some interesting statistics to show that albuminuria is of frequent occurrence in cases of diphtheria not treated with antitoxic serum. One observer found it in 131 out of 279 cases ; another in 16 out of 53 ; another in 60 per cent. of all his cases ; another in 227 out of 470. Suppression of urine has also been ascribed to the action of this agent ; but here again, if a careful search be made of the records of diphtheria cases treated under the old method, it will be found that just as in scarlatina and acute specific infective diseases generally, but especially in those associated with rapidly supervening toxic symptoms, suppression of the urine is of common occurrence ; and until we have statistics on these several points, which can be compared with those above mentioned, it will be impossible and unjust to ascribe conditions to the therapeutic agent which, so far as those best able to judge can see, are to be ascribed to the disease itself.

It has been held by some that the paralysis which is so common a sequel of diphtheria should disappear entirely under the use of what they are pleased to call a specific cure for the disease. It should be remembered that the antitoxic serum cannot make good any organic damage that has been caused by the action of the toxic products of the diphtheria bacillus. It may stop their action on the tissues, and it may stimulate the tissues to react against the poison, but to the tissues themselves must be left the process of repair ; the *vis medicatrix naturæ* is alone responsible for the making good of damage already done. This damage may be done at a very early stage of the disease, and if the nerves or the muscles are attacked before the antitoxine is injected, then we must expect to find degenerations and evidence of these degenerations in the various forms of post-diphtheritic paralysis ; but of this we may be sure, the sooner the poison is antagonised the less will be the risk of permanent damage to the tissues. It is for this reason, I believe, that the antitoxic serum treatment of diphtheria has been so much more successful than the antitoxic serum treatment of tetanus.

Conclusion.

The hope of success in diphtheria depends upon the early application of the remedy. One word of warning. It should not be accepted that this agent can reduce the cure of diphtheria to a mere process of injection. Everything must be done to improve the conditions under which the patients are treated, to maintain their strength, to give them fresh air, cleanly surroundings and good general hygienic conditions. It will be found withal that a certain number of deaths from rapid poisoning will take place, while a number of others will succumb in the later stages of the disease. This serum can no more act as a specific in every case than can quinine cure every case of malaria ; but if properly used, we believe it will reduce the mortality in a very marked degree, and if at the same time those practical sanitary reforms and improvements for which our country is so justly renowned are carried out, we may expect that diphtheria as a scourge may gradually die out from our midst. As Dr. Seaton pointed out at Buda-Pesth, we have done more in this country to improve the conditions associated with most specific infective diseases than any other nation in the world. If, now, we can graft on to our system what is best in Behring's treatment, I am convinced that we shall soon have diphtheria statistics which will compare very favourably with any that have yet been presented. The antitoxic serum treatment is only one of our lines of defence against this disease ; but so much progress has already been made along this line, that within a few years, or even months, we may fairly anticipate the announcement of still greater advances and successes.

DR. DUBOIS' SO-CALLED MISSING LINK.[1]

AT a meeting of the Roval Dublin Society, held on Wednesday, January 23, Dr. D. J. Cunningham, F.R.S., Professor of Anatomy in the Universitv of Dublin, and Hon. Secretary of the Society, read a paper upon the characters presented by the fossil remains recently described by Dr. Eugene Dubois. (See NATURE, January 24, p. 291.) The following is an abstract of this communication.

The fossil remains are three in number, viz. : the upper part of a cranium, a right-upper wisdom tooth, and a left femur. These are believed to belong to the Pleistocene period, and, according to Dubois, present characters which justify him in placing the animal to which they belonged in a new family which stands midway between man and the apes. The specimens were found in Java, on the left bank of the Bengawan River, in the neighbourhood of Trinil. Each was exhumed at a different time, but all at the same level, viz. 1 m. below the dry-season level of the river, and from 12 to 15 m. below the level of the plain through which the stream has cut its way.

The characters assigned to the new family proposed by Dubois are the following: "Cranium absolutely and relatively to body-size, much more roomy than in simiidæ, but less roomy than in hominidæ; cranial capacity about two-thirds of the average capacity of the human cranium. The inclination of the cervical surface of the occiput distinctly stronger than in simiidæ. Dentition after the type of the simiidæ. Femur similar in its dimensions to that of man, and designed for the upright walk and attitude."

The leading peculiarities of the cranium of the so-called Pithecanthropus are: (1) the low depressed character of the cranial arch; (2) the extreme narrowness of the frontal region; and (3) the striking development of the superciliary ridges. These are all to some extent simian features: and when outlines of the antero-posterior cranial arch of an ordinary Irish skull, of the skull of a microcephalic idiot (the brain of which presented many atavistic characters), of the fossil cranium, and of the skull of a young female gorilla, are reduced to the same size and superimposed over each other, it is seen that the idiot cranium and the fossil cranium present almost identically the same curvature; further, these two outlines occupy a place almost exactly midway betweeen the Irish cranial outline and that of the gorilla. (Fig. 1.)

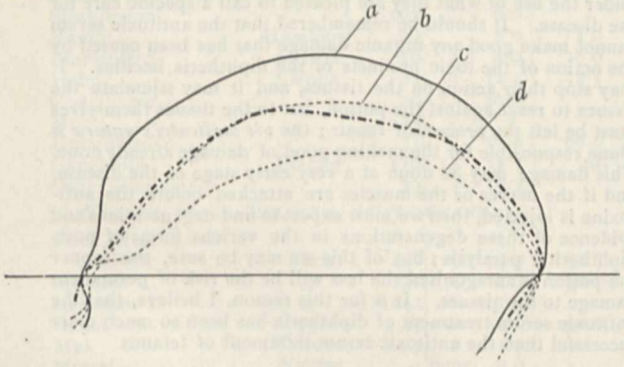


FIG. 1.—Outlines of the cranial arch of: *a*, ordinary Irish skull; *b*, skull of a microcephalic idiot; *c*, the fossil cranium described by Dubois; *d*, skull of a gorilla. The base-line is one which passes through the external occipital protuberance behind, and the centre of the glabella in front.

Another combination, equally interesting and equally instructive, is one in which the outlines of the antero-posterior cranial arch of the fossil form, of the Neanderthal skull, of the Spy cranium No. 2, and of the ordinary Irish skull, are superimposed over each other. (Fig 2.) In this the Neanderthal arch is seen to present almost exactly the same characters as those of the fossil form, and, further, to lie nearer to it than to the outline of the arch of the modern Irish skull. The Spy cranium No. 2 takes its place between the normal skull and the Neanderthal cranium, so that by a series of easy and nearly equal gradations we are led from the fossil form up through the Neanderthal and Spy forms to the modern cranial arch.

The heavy, strongly marked superciliary ridges constitute another Neanderthaloid feature of the fossil form, but the transverse frontal diameter is very much less than that of the Neanderthal or Spy crania. In this respect the fossil cranium closely approaches the microcephalic skull referred to above, and also the skull of the gorilla.

When the measurements of the fossil cranium are compared with those of the Neanderthal and Spy skulls, other striking resemblances become manifest.

—	Maximum antero-posterior diameter.	Maximum transverse diameter.	Cephalic index.	Cranial capacity
Fossil cranium	185	130	70	1000(?)
Neanderthal cranium ...	200	144	72	1200(?)
Spy cranium No. 1 ...	200	140	70	—
Cranium of intelligent adult woman measured in the Anthropometric Laboratory of Trinity College	167	139	83·2	—

The fossil cranium is thus only 15 m.m. shorter and 10 m.m. narrower than the Spy cranium No. 1. In every anthropometric laboratory intelligent individuals are occasionally measured who possess an antero-posterior cranial diameter very much less than that of the fossil cranium. In these cases, however, the head is usually brachycephalic, and presents a high and full cranial arch. In the above table the diameters of one of the smallest heads measured in the Dublin University Laboratory are given.[1]

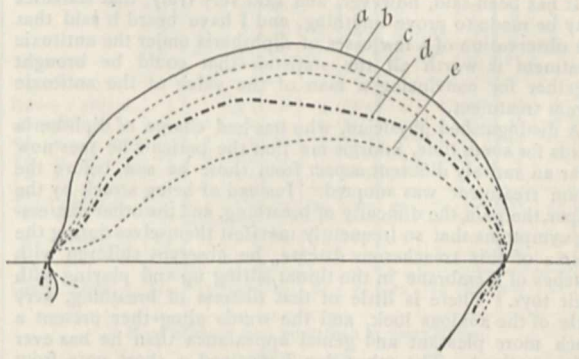


FIG. 2.—Outlines of the antero-posterior cranial arch of: *a*, ordinary Irish skull; *b*, Spy cranium No. 2; *c*, Neanderthal cranium; *d*, the fossil cranium described by Dubois; *e*, the skull of a gorilla. Base-line the same as in Fig 1.

Dubois calculates, from a comparison with ape crania, that the fossil specimen had originally a capacity of at least 1000. The average capacity of the European skull may be said to range from 1400 to 1500 (Welcker), and the Neanderthal cranium has been computed to have had a capacity of 1200. In this respect, therefore, the Neanderthal skull takes an intermediate place between that of the fossil form and of the European. Further, it should be borne in mind that a capacity of 1000 is usually regarded (as indeed Dubois points out) as being the physiological minimum for the human cranium.

From these considerations the fossil cranium described by Dubois is unquestionably to be regarded as human. It is the

[1] "Pithecanthropus erectus, eine menschaenliche Ubergangsform aus Java." By Eugene Dubois. (Batavia, 1894.)

[1] A female cranium from the Island of Inishboffin on the west coast of Ireland presents an antero-posterior diameter of 178 m.m., and a transverse diameter of 129 m.m. In both of these diameters, therefore, it is smaller than the Java fossil cranium. It differs from the latter, however, in possessing a very lofty antero-posterior cranial arch.

lowest human cranium which has yet been described. It presents many Neanderthaloid characters, but stands very nearly as much below the Neanderthal skull as the latter does below the ordinary European skull. The similarity in form which it presents to the microcephalic cranium, with which it has been compared, is undoubtedly interesting, but on this account we are not to conclude that it belonged to a person of feebler intellect than others of the same race. The Neanderthal skull was supposed by certain observers at one time to have been that of an idiot, but this idea was disposed of when other crania, presumably belonging to the same geological period, and possessing similar characters, were discovered. That the fossil cranium should in many respects resemble certain microcephalic skulls, is not surprising: indeed, to some extent it was to have been expected, seeing that a considerable number of this class of idiots present undoubted atavistic characters in so far as brain and cranium are concerned.

Dubois, in his description of the fossil cranium, institutes a close comparison between it and the crania of the higher apes, and only incidentally touches upon its relationship with the human cranium. He asserts that no good could arise from a comparison between it and the Neanderthal and Spy remains, seeing that the latter are pathological. It is not within the scope of an abstract, such as this, to take up the gauntlet on a question of this kind. It will be sufficient to assert an entire accordance with the views so ably advocated by Prof. Huxley, viz. that the Neanderthal and Spy crania are typical of the earliest human race with which we are acquainted.

It is not necessary to delay over the femur. That it is human in every respect, no one could for a single moment doubt. Further, it is curious to note that its form and proportions are more those of a modern than of a prehistoric thigh-bone. It presents none of the characters which distinguish the Spy femora. Its length is 455 m m., therefore the height of the individual to whom it belonged must have been 1654 m.m., or, in other words, about the same as that of an average Frenchman.[1] From the fact of the femur being found at a distance of from 12 to 15 m. from the place where the cranium was discovered, as well as from other considerations, it is very unlikely that the two specimens belonged to the same individual.

The tooth is undoubtedly a very remarkable specimen. Its great size and strong divergent fangs are characters which at first sight appear to separate it widely from an ordinary human upper wisdom tooth. But we know that in low races, such as the Australian and the Negro, and also in the ancient Neanderthaloid race, the wisdom tooth has not undergone the same retrograde changes which we observe in the European and other mesognathic or orthognathic people. If we take the mean of the antero-posterior and the transverse diameters of the crown of the fossil tooth, we get a result of 13·3. A right upper third molar extracted from the jaw of a negro, treated in the same way, yields a result of 11·5, whilst three Irish upper wisdom teeth, selected at random, give an average of 9. The negro tooth is thus seen, in point of size, to be as far removed from the European tooth as the fossil tooth is from it, and the same may be said for the condition of the fangs. The fossil tooth, so far as one can judge from the figure, is fashioned more after the human model than the simian. The variability of an upper wisdom tooth in man is very remarkable, not only in regard to size, but also in the disposition of its cusps and fangs.[2]

From what has been said, it will be seen that the skull and the tooth, even granting that they are from the same individual, present no such characters as would warrant the formation of a new family. The cranium at least is undoubtedly human. Most certainly they are not derived from a transition form between any of the existing anthropoid apes and man; such a form does not and cannot exist, seeing that the divarication of the ape and man has taken place low down in the genealogical tree, and each has followed, for good or bad, its own path. The so-called Pithecanthropus is in the direct human line, although it occupies a place on this considerably lower than any human form at present known.

[1] Topinard gives the average height of the French as 1650 m.m.

[2] In the museum of the Dublin School of Dental Anatomy there is an upper wisdom tooth extracted from the maxilla of an Irish man, the crown of which presents a transverse diameter of 13 m. m., and an antero-posterior diameter of 12 m.m. (mean result 12·5); which possesses seven cusps and four stout fangs: two of the latter being partially fused. This tooth is very little smaller than the wisdom tooth of the fossil form, and is more remarkable in the way of cusps and fangs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Biological Club held its jubilee meeting on Saturday last, when the professors of the biological faculties in the University were entertained to a commemorative dinner given in Merton College. The ravages of influenza unfortunately deprived the Club of the presence of several familiar members and of more than one expected guest; but the presence in Oxford of Prof. Bayley Balfour gave the Club an opportunity of extending its welcome to an old friend and an additional distinguished visitor. In the absence of Mr. G. C. Bourne, the presidential chair was taken by Mr. Henry Balfour, of Trinity. Profs. Bayley Balfour and Lankester replied for the guests.

In accordance with a recommendation from the Board of Faculty of Natural Science, the Council has approved of the subject of Astronomy being added to the list of subjects which may be offered in she Honour School of Natural Science. For a reason which is not very obvious at first sight, a candidate who offers Astronomy as a final subject must have obtained honours in the first or second public examination, but need not have passed any of the preliminary science examinations; and a candidate who has passed the science preliminaries is not eligible to compete in the Honour School of Astronomy unless he has obtained honours in the first or second public examination. The object of this rule, which places the School of Astronomy in a position different to that of any other science school, is to compel candidates to take Honours either in Mathematical Moderations or Finals before entering on Astronomy. But the object is not attained, for as the statute now runs, a man who has taken honours in Classical Moderations or in any Final Honour School may enter for the Astronomical School, whilst a man scientifically trained cannot. It may be hoped that the rule, which as it stands is absurd, may soon be rectified. The subject of Astronomy has long been an optional or additional subject in the Honour School of Natural Science, but like other additional subjects, has not attracted students. Astronomy having asserted its claims to recognition, Anthropology has followed its lead, and the Faculty of Natural Science has by a large majority sent up a recommendation to Council that the subject of Anthropology should be added to the Final School. The answer of Council has not yet been received.

In a Congregation held last week, the Curators of the University Chest were empowered to make sundry payments to the Curators of the Botanic Garden, to bring up the whole income of the Garden during each of the next four years to a sum sufficient to defray its expenses.

Mr. G. C. Bourne, Fellow of New College, has been elected a Delegate of the University Museum, in place of Mr. E. Chapman, Fellow of Magdalen College, resigned.

CAMBRIDGE.—The vacancy in the Sadlerian Professorship, caused by the death of Dr. Cayley, has been filled up by the election of Dr. A. R. Forsyth, F.R.S., University Lecturer in Pure Mathematics. Dr. Forsyth is well known as the author of standard text-books on Differential Equations and the Theory of Functions, and of many papers on the higher branches of pure mathematics. He is a Fellow of Trinity, and a member of the Council of the Senate.

Dr. Charles Waldstein, Reader in Classical Archæology, has been elected to the Slade Professorship of Fine Art, vacant by the retirement of Prof. Middleton.

A shower of "fly-sheets" has fallen on the University on the question of requiring further evidence of power to write essays in the various degree examinations. The questions will be decided by the vote of the Senate on Thursday afternoon.

SINCE 1892 there has been a decrease in the number of candidates for entrance into the Central Technical College at South Kensington. But though fewer candidates have presented themselves, the number admitted is about the same, indicating either that the examiners lowered the matriculation standard, or that candidates were better prepared for the examination. In the report of the work of the College during the session 1893-94, various causes are given to account for the diminution of candidates. One is the great increase of facilities for obtaining technical education in London and in the provinces since the College opened. To what extent this in-

crease of schools for technical education may help or hinder the development of the Central Technical College remains to be seen. If to some extent it increases the competition for students, on the other hand it may, in the long run, more than compensate for this by increasing the public appreciation of the value of technical education. It is also suggested that probably the falling off in the number of candidates for admission is chiefly due to the continued commercial depression, and happily this is a disadvantageous condition which may be expected to pass away.

A copy of the programme of the College, received at the same time as the report, shows that the College is far and away in advance of similar institutions in London, and is in the highest degree competent to provide "for the higher technical education, in which advanced instruction shall be provided in those kinds of knowledge which bear upon the different branches of productive industry, whether manufactures or arts."

SCIENTIFIC SERIALS

American Journal of Science, February.—On the relation of gravity to continental elevation, by T. C. Mendenhall. Determinations of the intensity of gravitation made by the Coast and Geodetic Survey, and by Commander Defforges, and extending across the North American continent, bring out the fact that the deviations from the values of gravitation as deduced from the theoretical shape of the earth's spheroid, are in a direct relation to the elevation of the observing station above sea-level. An explanation based upon differences in the density of the surface layers is difficult to find, but the fact is undoubted.—Glacial phenomena of Newfoundland, Labrador, and Southern Greenland, by G. F. Wright. The ice-sheet of Southern Greenland formerly sent glaciers down through all the fiords, filling them to a height of about 2000 feet, and pushing even to the very margin of the continent. Greenland, therefore, like the rest of the world, has had its ice age, which has already partially passed away. During the maximum of the ice extension, the mountains bordering the sea in Southern Greenland formed innumerable "nunataks." The ice was not thick enough to cover them in solid mass, and there is no probability that the ice extended far out into Davis Straits. In Labrador and Newfoundland, on the other hand, all the mountains were completely covered with glacial ice, which extended far out over the bordering continental plateau. The facts point to considerable preglacial elevations of land, followed in Labrador, at least, by a period of extensive depression below the present level, and subsequent gradual elevation. There is evidence of the recent date of the glacial period, while the indications of recent changes of level point to terrestrial rather than astronomical causes to account for the vicissitudes of the glacial period.—The *Pithecanthropus erectus*, Dubois, from Java, by O. C. Marsh (see pp. 428-29).

Bulletin of the American Mathematical Society, vol. i. 4 (New York, January 1895).—A pathetic interest is attached to the second article, "Note on a memoir in Smith's collected papers," as it must have been amongst the last pieces of work done by Prof. Cayley. The memoir is that on the Theta and Omega Functions (Smith papers, vol. ii. pp. 415-623). The notice is a very slight one, and gives an abstract of the contents of the memoir.—The opening paper is a presidential address, delivered before the American Mathematical Society at its annual meeting, December 28, 1894, of which the title is, "The Past and Future of the Society." Dr. McClintock traces the growth of the Society from its origin in 1888 as a small mathematical club, meeting at Columbia College, whose first meeting was called by a circular signed by three young men, up to its present membership of 251. A paragraph points out that the pioneer of all these mathematical societies which have subsequently sprung up was the London Mathematical Society. "There had been no previous example of a similar organisation, and fears were felt and expressed that its management might naturally drift into the hands of a few having time and energy to give to its affairs, and that there might thus be serious danger of its falling into the control of a clique. The lapse of time has developed the fact that the leading members of that Society have been men of broad views, unusually free from personal prejudice, and quick to recognise talent wherever displayed. We may almost conclude from the history of that Society that proficiency in the science of mathematics is distinct evidence of a well-balanced mind." We repeat the wish we have previously expressed for the continued success of this flourishing young branch. In the Notes the new officers and Council are given, the new President being Dr. George W. Hill.—A long list of new publications closes the number.

IN the numbers of the *Journal of Botany* for January and February, new plants are described by Mr. A. Fryer from Scotland (a new hybrid *Potamogeton*); by Mr. R. P. Murray, from Tenerife; by Mr. W. Fawcett, from Jamaica; and by Mr. H. N. Ridley, from the Malay Peninsula. Mr. A. Bennett discusses the claims of *Juncus tenuis* to rank as a British species.

SOCIETIES AND ACADEMIES.

LONDON

Chemical Society, February 7.—Dr. H. E. Armstrong, President, in the chair.—The following papers were read: The action of heat on ethylic β-amidocrotonate; Part ii., by J. N. Collie. During the destructive distillation of this salt, αγ-dimethyl α¹-ethoxypyridine, a dimethylpyrrol and a pyridine derivative, $C_6H_8N_2O$, are produced together with ethylic lutidonemonocarboxylate.—The acidimetry of hydrogen fluoride, by T. Haga and Y. Osaka. Phenolphthalein is the best indicator to use in the titration of hydrofluoric acid. The authors' experiments with litmus suggest that the molecular composition of hydrogen fluoride is H_3F_3 or H_4F_4.—Composition of ancient silver ornaments from Peru, by Miss C. Walker.—Molecular change in a silver amalgam, by Miss F. T. Littleton.—On heating silver amalgam, preferably of the composition $Ag\,Hg_4$, considerable swelling occurs; this can only be attributed to molecular change, inasmuch as gas is not evolved.—Sulphocamphylic acid II., by W. H. Perkin, jun. Further evidence has been obtained indicating that this acid has the composition $C_8H_{12}(SO_3H).COOH$; the acid yields two isomeric acids $C_8H_{11}.COOH$ on fusion with potash. Other new derivatives have been obtained.—Derivatives of ethyloxthotoluidine, by W. MacCallum, jun.—Acetyl derivatives of benzaconine and aconitine, by W. R. Dunstan and F. H. Carr. A number of unsuccessful attempts have been made to convert benzaconine into aconitine by introducing an acetyl group; two isomeric triacetylbenzaconines and a tetracetylbenzaconine are obtained on acetylation. The authors have also prepared di- and tri-acetylaconitine and triacetylpyraconitine.—Aconitine aurichlorides, by W. R. Dunstan and H. A. D. Jowett. A new examination of the three modifications of aconitine aurichloride confirms the authors' previous assertions as to the existence and nature of these compounds. The alcoholate of aconitine aurichloride described by Freund and Beck is the β-aurichloride containing a little alcohol.

Entomological Society, February 6.—Prof. Raphael Meldola, F.R.S., President, in the chair.—The President announced that he had nominated the Right Hon. Lord Walsingham, F.R.S., Mr. Henry John Elwes, and Prof. Edward B. Poulton, F.R.S., Vice-Presidents of the Society for the Session 1895-96.—Mr. W. F. H. Blandford made some remarks regarding Mons. Brongniart's donation to the library, of his monograph entitled "Recherches pour servir a l'histoire des Insectes Fossiles des Temps Primaires." Mr. Blandford also called attention to figures of pupæ of species of *Spalgis* (Lycænidæ), in the *Journal* of the Bombay Natural History Society. A discussion followed, in which Mr. Hampson and Mr. McLachlan took part.—Canon Fowler exhibited, on behalf of Mr. C. A. Myers, an unusually fine specimen of *Sphæria robertsi*, growing from the prothorax of an underground larva of a Hepialus, supposed to be *H. virescens*, from New Zealand. Mr. McLachlan said that there was a doubt whether the caterpillar should be referred to this species. Mr. Blandford stated that the French Government had set aside a section of the Pasteur Institute at Paris for the study of entomophagous fungi.—Prof. L. C. Miall, F.R.S., and Mr. N. Walker, communicated a paper entitled "On the Life History of *Periscoma canescens* (Psychodidæ)," with an Appendix by Baron Osten-Sacken.—Herr Jacoby read a paper entitled "Contributions to our Knowledge of African Phytophagous Coleoptera." Dr. D. Sharp, F.R.S., remarked that Erichsen began the "In-

sekten Deutschlands" some sixteen years ago, and as he was engaged on a classification of the Coleoptera of the world, he included a considerable number of these exotic species in his work.—Mr. G. F. Hampson read a paper entitled "Descriptions of New Heterocera from India."

Mineralogical Society, February 5.—Dr. Hugo Müller, F.R.S., in the chair.—Prof. Judd read a paper on some simple crystalline rocks (massive minerals) from India and Australia. From specimens supplied by Mr. T. H. Holland, of the Geological Survey of India, Mr. P. Bosworth Smith, late Government Mineralogist at Madras, and Mr. C. Barrington Brown, the author was able to make known some new types of rocks. Two remarkable forms of corundum-rock were noticed, one from Pipra, S. Rewah, first brought to the knowledge of mineralogists by Mr. F. R. Mallet, and the other from Hunsúr Talug, in the Mysore State. A fibrolite-rock, derived from the same district as the last, was also noticed. A new variety of tourmaline (schorl)-rock with a fibrous texture, having a wide distribution in India, was likewise described, and an analysis, together with a description of the optical properties of the mineral, was given. From the Bingera district in New South Wales, two dykes were described as traversing masses of serpentine, one being composed of a green garnet-rock (grossularite?) yielding gold, and the other of picotite, the chrome-spinel. —The Earl of Berkeley read a paper on an accurate method of determining the densities of solids, in the course of which it was shown that by taking suitable precautions with a pyknometer having a thermometer stopper and a capillary at the side, results accurate to 0·03 per cent. could be obtained. The actual values for different crops of rubidium alum were 1·8884, 1·8885, 1·8885 and 1·8889. The chief point of the communication was that the evaporation of the liquid used in the observations (CCl_4) from the film formed between the stopper and the neck of the pyknometer, instead of being a source of error, is utilised to bring the level of the liquid into coincidence with the mark on the capillary.—Prof. Church made a communication on the dererminaiion of mineral densities. Three points were specially referred to: The employment of dilute alcohol instead of water was recommended as enabling full advantage to be taken of the sensitiveness of an assay balance; the results quoted for specimens under two grams in weight were probably correct to ·003. A method of removing interstitial air by first replacing it with carbon dioxide, and then absorbing this gas by an alkaline solution or byboiled water was described. An account was next given of a method of determining relative densities by means of mercury, the volume of mercury displaced by the mineral being weighed. Although no novelty was claimed for these methods, special precautions in their conduct were named, and illustrations adduced of their application to the determination of mineralogical problems.

CAMBRIDGE.

Philosophical Society, February 11.—Prof. J. J. Thomson, President, in the chair.—On a method of determining the conductivities of badly conducting substances, by Prof. J. J. Thomson. A sphere of the substance the conductivity of which is to be determined is placed inside a coil A through which very rapidly alternating currents are passing. The currents induced on the sphere react on those in the coil. A small coil B placed in series with A contains a highly exhausted bulb in which a ring discharge is produced by the alternating currents. Any change in the intensity of the currents through A produces a change in the brightness of the discharge through the bulb inside B. The effect produced by the sphere inside A is measured by the change in the brightness of the discharge within B, and as the effect produced by the sphere depends on its conductivity, the observation of changes in the brightness of the discharge makes it possible to compare the conductivities of different substances. The paper contains applications of this method to the study of the conductivity of electrolytes under very rapidly alternating currents, of rarefied gases, of gases when entering into chemical combination, of flames, and of the effect of the formation of drops of water from aqueous vapour.—Note on the calibration of the wire of a Wheatstone bridge, by Mr. E. H. Griffiths.

BERLIN.

Physiological Society, January 4,—Prof. du Bois Reymond, President, in the chair.—In the discussion on Prof. Waldeyer's discourse (of December 21, 1894), Dr. Benda and Dr. Rawitz laid stress on the anatomical difficulties which stand in the way of the generalisations of Golgi's school, and Prof. Gad made his protest from the physiological point of view. Prof. Waldeyer recognised the propriety of the objections made against the newer views as to the minute anatomy of the nervous system, views due to those recent methods of research which have led to a very distinct advance in knowledge. Dr. Ziegenhagen communicated the results of his researches on the development of the blood-vessels in trout-embryos, based on observation of the living object, on injections by Wertheim's method, and on photographs.

January 18.—Prof. du Bois Reymond, President, in the chair. —Dr. Benda explained the preparations he exhibited of nerve-endings in muscles made by Prof. Sihler, of Cleveland. —Dr. Rawitz described a new method of staining cells with aniline dyes, which consists in first mordanting the tissues, hardened in Flemming's fluid, with tannin and tartar-emetic, and then treating them with the dye. By this method of "adjective" staining, only the protoplasm of the cell is coloured, not the nucleus. The same speaker next described some results of his method as applied to resting-cells of salamander testis. The nucleus shows the brown-coloured chromatin filaments; the linin network and the distinct nuclear membrane are of a pale red colour. In the middle of the protoplasm, at some distance from the nucleus, is the dark-red attraction sphere with the centrosome in its midst. Close-set meshes of the network of red fibrils, which permeate the protoplasm, and are in other parts less close-set, join on to the periphery of the sphere, and are in direct communication with the nuclear membrane and the linin filaments. Occasionally the attraction spheres of two neighbouring cells are joined together by a dark-red filament.—Dr. Cohnstein described experiments on the action of intravenous injections of sodium chloride on the composition of lymph and blood, and showed that the observed variations of quantity and of the amount of water and salt in the lymph, as also the changes in the amount of salt in, and concentration of the blood, could be adequately explained by the purely physical processes of diffusion and filtration.

Meteorological Society, January 8.—Prof. Hellmann, President, in the chair.—Dr. L. A. Bauer discoursed on the secular changes of terrestrial magnetism. From the observations available at an extended series of stations he had determined the declination and dip of a magnetised needle freely suspended at its centre of gravity, and had compared the curves of secular change thus obtained with the corresponding formulæ. Taking older compass-charts additionally into consideration, he found that the curves of secular change must contain loops. If one imagines a magnetised needle, freely suspended at its centre of gravity, to be carried round the earth along a given parallel, one obtains the momentary curve of terrestrial magnetism for that parallel, and this curve corresponds to the curve of secular variation. This curve further shows a distinct loop, as, for example, for the parallel 40° N. In the discussion which followed, the President drew attention to the fact that the statements of the older travellers as to compass bearings cannot well be used for determining the components of terrestrial magnetism, since each compass was specially arranged in order to show the astronomical north-pole, and hence it is necessary, first of all, to know what this special arrangement was before their indications can be used.—Dr. Kassner described a "föhn" wind in the Riesengebirge, which was very marked on November 1 and 2 last, on the north fall of the mountain, and caused by the high temperature and excessive dryness. The dryness and great transparency of the air was observed as far as Breslau, a distance of 100 kilometres.

Physical Society, January 11.—Prof. du Bois Reymond, President, in the chair.—Dr. Altschul made communications from the Raoul Pictet Institution, dealing first with the influence of intense cold ($-70°$ to $-200°$ C.) on a long series of chemical processes, and in the next place on physical processes, such as phosphoresence, &c. He then reported upon experiments on the behaviour of bodies at the critical temperature. The disappearance and reappearance of the meniscus was found to take place always at the same temperature as long as the warming of the substance was uniform. It was found that the critical temperature is a better criterion of the chemical purity of a liquid than are its melting point and boiling point, and a number of instances were cited where minute impurities altered the critical temperature by many degrees. Solutions of solids when heated above the critical temperature gave no precipitate,

the solid remaining dissolved in the gaseous vapours. Solutions of colouring matter behaved similarly.

January 25.—Prof. du Bois Reymond, President, in the chair.—Mr. Archenhold discussed the principles and advantages of two recently projected telescopes, of which one with a 44-inch object-glass and short focal length is to be set up in the Berlin Industrial Exhibition in May 1896, while the second, with a 50-inch object-glass, is to be taken in hand later on. The glass for the first of the two is already cast by Dr. Schott, of Jena, and is to be ground according to scientific principles by Dr. Steinheil. The speaker further discussed a series of fundamental novelties in the mounting of the telescopes, by which the cost of the same would be materially reduced. The discussion, which was then opened by Prof. von Bezold, on behalf of Profs. Auwers and Vogel, and continued by Prof. Lummer, was adjourned to the next meeting.

[*Notice.*—In the report of the meeting of the Physiological Society of December 7, 1894, NATURE, vol. li. p. 288, for "Dr. G. Joachim," read "Dr. G. Joachimstal."]

PARIS.

Academy of Sciences, February 18.—M. Marey in the chair.—On Neumann's method and Dirichlet's problem, by M. H. Poincaré.—On the form of the intrados of arches, by M. H. Resal.—On the kinds of chlorophyll; remarks *à propos* of the note by M. Étard, by M. Arm. Gautier. The author claims priority for the proof that several chlorophylls exist, and that chlorophyll contains no iron, but contains organic phosphorus.—On the agricultural value of aluminium phosphates; remarks *à propos* of M. Andouard's note, by M. Arm. Gautier. In 1893 the author showed that amorphous aluminium phosphate was of value in agriculture owing to its solubility in the products of decomposition present in soils. This does not extend to crystallised phosphates of aluminium or of aluminium and calcium.—On the estimation of tannic compounds, by M. Aimé Girard.—Remarks on atomic weights, by M. Lecoq de Boisbaudran. The author mentions a method of classification of the elements which enables him to calculate their atomic weights as well as predict their properties; this system has not yet been published. According to it, argon belongs to a group of elements of which no other members are yet known. They should be octads of atomic weights as follows: 20·0945, 36·40 ± 0·08, 84·01 ± 0·20, 132·71 ± 0·15; (O = 16). They should be metalloids, the first two members relatively abundant, the others rare. Taken in order, they should respectively be more volatile than oxygen, sulphur, selenium, and tellurium.—The scope and method of a work on the "theory of algebraical functions and their integrals," by M. Appell and M. Édouard Goursat, is explained in a short note by the former.—On the astronomical inscription of Keskinto, by M. Paul Tannery. The author draws conclusions with regard to the state of knowledge of planetary periods about 150-50 B.C.—On a surface of the sixth order, allied to abelian functions of the third type, by M. G. Humbert.—On the properties of amorphous silicon, by M. Vigouroux. These properties are very fully given. Speaking generally, amorphous silicon prepared by reduction with magnesium somewhat resembles crystalline silicon in properties. Though somewhat inert at lower temperatures,, at high temperatures it is chemically very active.—On the oxidation of the tannin of the cider apple, by M. L. Lindet. This oxidation appears to be due to the action of a ferment of the *laccose* type.—On the composition and analysis of eaux-de-vie, by M. X. Rocques.—On the seeds of the Moâbi, by MM. H. Lecomte and A. Hébert. An account of a tree found in French Congo, and of a fat produced from its seeds.—On ferrocyanide, rutheniocyanide, and osmiocyanide of potassium, by M. A. Dufet. A crystallographical paper giving measurements of axial ratios, angles, and optical constants of (1) $K_4FeCy_6.3H_2O$, (2) $K_4RuCy_6.3H_2O$, (3) $K_4OsCy_6.3H_2O$. A remarkable similarity is shown by these compounds throughout the extensive series of measurements given.—On modifications of the blood, brought about by the thermal treatment with Bourboule water from the spring Choussy-Perrière, by M. Ph. Lafon. Conclusions from results of many analyses (quoted): (1) In cases of chloro-anæmia there is generally a notable increase of red corpuscles and oxyhæmoglobin in the blood of patients, due to the treatment. (2) In cases of leucocytæmia the treatment produces a diminution of the numbers of white corpuscles.—On the nucleus and nuclear division in the *Benedenia*, by M. Alphonse Labbé.—On egg-deposition of *Vespa crabro*, L.; conservation of heat in the nest, by M. Charles Janet.—Observations on the upper Tongrian or *Stampien* strata in the Chalosse, by M. L. Reyt.—Considerations on contact-metamorphism, derived from a study of the contact phenomena of lherzolite in the Pyrenees, by M. A. Lacroix.—Mineralogical composition and structure of the *silex* of the Paris gypsum, by M. L. Cayeux. Conclusions: (1) The siliceous nodules from gypsum, known as *silex*, have an essentially different microstructure and mineralogical composition from *silex* properly so called. (2) They result from a substitution of silica for gypsum. (3) The silicification of gypsum causes the production of some one of the arrangements of which quartz is capable. (4) The ultimate term of the series of transformations of saccharoidal gypsum, under the action of silica, is the production of wholly quartzose plates, having the same structure as quartzites.—Earthquake recorded at Grenoble, a note by M. Kilian, February 3, 6h. 2m. 40s. morning.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Introduction to Physiological Psychology: Dr. Th. Ziehen, translated, 2nd edition (Sonnenschein).—An Elementary Text-Book of Anatomy: Prof. H. E. Clark (Blackie).—Report of Observations of Injurious Insects, &c., 1894: E. A. Ormerod (Simpkin).—Economic Classics—David Ricardo (Macmillan).—Economic Classics—Adam Smith (Macmillan).—A Course of Elementary Practical Bacteriology: Drs. Kanthack and Drysdale (Macmillan).—The Pathology of Mind: Dr. H. Maudsley (Macmillan).—Notes on a Journey on the Upper Mekong, Siam: H. W. Smyth (Murray).—Das System der Übergewalt oder das Analytisch-Synthetische Princip der Natur: K. Beyrich (Berlin, Oppenheim).

PAMPHLETS.—Revue de l'Aéronautique, 1893, 3e Livr.: Le Travail Intérieur du Vent: S. P. Langley (Paris, Masson).—Tableau Oeconomique: F. Quesnay (Macmillan).—Philosophical Transactions of the Royal Society of London, Vol. 185 (1894) A, pp. 93-121: Propagation of Magnetisation of Iron as affected by the Electric Currents in the Iron: J. Hopkinson and E. Wilson (Dulau).

SERIALS.—Brain, Part 69 (Macmillan).—Royal Natural History, Part 16 (Warne).—English Illustrated Magazine, March (198 Strand).—London Home Monthly, March (Cox).—Journal of the Royal Microscopical Society, February (Williams and Norgate).—Good Words, March (Isbister).—Sunday Magazine, March (Isbister).—Chambers's Journal, March (Chambers).—Longman's Magazine, March (Longmans).—Le Monde Moderne, February (Paris, Quantin).—Century Magazine, March (Unwin).

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