THURSDAY, APRIL 29, 1886

FLOWERS, FRUITS, AND LEAVES

Flowers, Fruits, and Leaves. By Sir John Lubbock, Bart., M.P., &c. "Nature Series." (London: Macmillan and Co., 1886.)

THE President of the Linnean Society sets a good example. Not many men, we suppose, have more onerous or more multifarious duties than he. He earns his leisure, little though it be, and he makes excellent use of it. Flowers, fruits, and leaves, to say nothing of insects and archæological investigations, supply him with the recreation he needs, provoke his observation, and stimulate his intelligence. More than that, they make him a propagandist. He is anxious to share with others the pleasure and relief he obtains from the study of Nature. To this end he descends from the Presidential chair to converse familiarly on the objects of his study, not only with those who are already in sympathy with him, but with those benighted Philistines whom perchance he may yet hope to gather into the fold. The substance of the book before us formed the basis of certain lectures addressed to popular audiences, and is well suited, with the accompanying illustrations, to arouse the attention of the indifferent and of that very large class of persons who go through the world with their eyes shut.

Two of the lectures, those on "Flowers," have been previously published. They contain references to the relationships between insects and flowers, to the visitations of the former to the latter, and other cognate matters with which the reading public has been familiarised. We need therefore only allude to the remaining chapters, treating of "Fruits and Seeds" and of "Leaves." The terms are throughout used in their popular and not in their strict technical acceptation, a circumstance which at once brings under notice the very different means by which the same effect or purpose is fulfilled. The general reader concerns himself far more with results than with the way in which they are brought about, and hence he sees no incongruity in grouping the winged flower-stalk of the lime, the "keys" of the ash or the maple, and the winged seed of the pine under one and the same heading.

Sir John humours this tendency. Probably he feels that the majority would be repelled by morphological disquisitions, genealogical dissertations, and transcendental speculations. These things come after. For the present the author dilates upon the form and appearance of the fruit and seed in relation to the necessities of their life and the purpose of their existence. He thus points out, on the one hand, the modifications and adaptations to secure adequate protection for the seed from the vicissitudes to which it is exposed, and, on the other, the divers means by which the dispersion of the seed is effected and its germination facilitated. Similarly, in the case of the leaves, the author discusses the probable causes of the exuberant variation met with in these organs. Whatever the cause, the result is doubtless consistent with the principle expressed by "the greatest happiness of the greatest number," the co-relations and adaptations met with secure the maximum of advantage possible to each leaf with the least interference with the requirements of neighbouring leaves. It is not often we should be disposed to cite Mr. Ruskin as an authority on botanical matters, but in the fifth volume of his "Modern Painters" he has to some extent anticipated Sir John, and given some striking illustrations of the mutual adjustments between the several leaves on the same branch.

The protection possibly afforded by the close resemblance of one plant (unprovided with other means of defence) to another duly equipped with defensive armour was not thought of in pre-Darwinian days. Sir John Lubbock in the volume before us gives several illustrations of the phenomenon which, whether we accept the explanation or not, are very striking. Attention is also called to the primordial leaves which succeed to the cotyledons or seed-leaves. In many cases, as in conifers and in most compound-leaved plants, the form of these adolescent leaves differs widely from that of the adult foliage. From these circumstances the obvious inference is drawn that plants with lobed or compound leaves are derivatives from ancestors that had leaves of simpler type. The seedling plant in such cases is assumed to repeat the form and appearance of its ancestors. If this inference is taken in a general sense, and not made too exclusive in its application, it will meet with general acceptance. But we do not think that we are entitled to assume direct genetic connection in all such cases. Of necessity simple leaves must precede divided or compound ones. Similarity of conditions and requirements would bring about, in the case of archaic and of recent plants respectively, similarities of form without any necessary direct hereditary connection between the two.

A few slips may be mentioned for correction in the next edition; thus, it is hardly correct to describe the leaves of *Desmodium gyrans* as perpetually moving round (p. 49); Stael (p. 114) should be Stahl; and the reference (at p. 93) to "Mr. Moore" requires further differentiation, as there are several Moores known to botanists. In this case Spencer Le Marchant Moore is probably intended.

We have said enough to show what varied sources of interest are opened up by Sir John Lubbock in this book. We trust that in future we may have further discussions of like nature from his pen, and we might suggest to him, as a complement to what he has here given us, a chapter on the significance of the various modifications of leaf-arrangement met with in Buds.

MAXWELL T. MASTERS

THE GEOLOGY OF PALESTINE

Memoir on the Physical Geology and Geography of Arabia Petræa, Palestine, and Adjoining Districts. By Edward Hull, F.R.S. (Under the auspices of the Committee of the Palestine Exploration Fund. 1886.)

MUCH has been written in recent years regarding the geology and natural history of that deeply interesting region which lies to the east of the Gulf of Suez, and includes the Basin of the Jordan River. Yet much still remains for further exploration, more especially in the way of more accurate detail and of connected analysis of the whole region. Recognising this deficiency of information, the Committee of the Palestine Exploration Fund towards the close of the year 1883 organised an expedition for the purpose of making a geological survey, or rather reconnaissance, of Western Palestine, and intrusted its conduct to Prof. E. Hull of the Geological Survey. The Report of this expedition is now issued as a handsome quarto volume of 145 pp., with maps and numerous woodcuts. Part I. gives an enumeration of the more important or accessible writings of previous observers, and a description of the physical features of the districts visited. Part II. deals with the geological structure of Arabia Petræa and Palestine, including the Archæan crystalline rocks, and the Carboniferous, Cretaceous, Tertiary, and Post-Tertiary formations. Part III. contains a brief account of the Tertiary Volcanic Rocks. Part IV. is devoted to a discussion of the dynamical operations which may have brought about the present geological structure of the region, and of the evidence of former differences of climate. Part V. treats of the origin of the saltness of the Dead Sea and of the recent climatal changes of that district. The scheme of treatment is thus comprehensive enough, and the details and conclusions are clearly expressed, though they hardly add as much as could have been hoped to what was already known on the subject. The discussion of the dynamical questions is disappointingly meagre. In the problem of the origin of the great Jordan Valley depression there was room for much detailed exposition, wherein a careful collection of the facts of geological structure could have been made conducive to a valuable addition to our knowledge of this important and still obscure branch of geological physics. The history of the surface-features of the region of Western Palestine is a question on which the Report throws very little fresh light, though it is the one to which perhaps above all others the members of a flying corps of observation might have been expected to be able to contribute valuable data. Regarding the changes of climate and the origin of the Dead Sea we should have looked for more new materials and a much fuller discussion than the few paragraphs in which this important subject is dismissed. No doubt Prof. Hull and his companions did as much in the way of observation during their brief visit as was possible in the time, and he has made all that probably could be made of it in this Report. But we are inclined to think that the subject was in such a position that little further could be usefully done to it by the rapid journey even of a trained observer through the country. If the Committee of the Palestine Exploration Fund want to have a satisfactory solution of the many profoundly interesting geological problems presented by Syria and Palestine, they must organise the task as part of the less rapid and more detailed survey of the general topography. The Report is excellently printed and illustrated, the maps being of especial value, containing as they do a summary of all that is known up to the present time regarding the distribution of the rocks in Palestine. There are some errors of the press which on revision the author will no doubt correct in another edition, and we would call his attention to a sentence which betrays his nationality, "The Patriarch Job, whether an actual person or a representative character, may be supposed to have inhabited the Plains of Edom" (p. 123).

A MANUAL OF CHEMISTRY

A Short Manual of Chemistry. Vol. I. "Inorganic Chemistry." By A. Dupré, Ph.D., F.R.S., F.C.S., &c., and H. Wilson Hake, Ph.D., F.C.S., F.I.C. (London: Charles Griffin and Co., 1886.)

"WHY should another hand-book on this subject be added to the many which already exist in the language?" In the first paragraph of their preface the authors anticipate the possibility of this question arising in the minds of some chemists, and they therefore answer it by (1) claiming their right, as teachers of lengthened experience, to record their methods of instruction; and (2) expressing their belief "that the very multiplicity of text-books already published tends to show a want felt, but not yet satisfied."

Their method consists in first laying down general principles which, when thoroughly mastered, are to be followed up with the facts of descriptive chemistry.

The introductory chapters containing these general principles, on which the student "with no previous knowledge of chemistry whatever" is to found his chemical education, comprise about 80 pages of the book, and since the authors lay so much stress on their importance, we cannot pass over this portion of the book without giving a few illustrations of what is to be learnt from the manual apparently intended to supersede all other text-books.

The representation of a molecule by two small circles surrounded by a larger circle (see note on p. 11) may perhaps be mentioned as an instance of the pertinacity with which so many teachers continue to do their best to confuse their pupils with erroneous conceptions of atoms and molecules.

On p. 36 the melting-point of a substance is incorrectly defined as "the temperature at which it is no longer capable of existing as a solid." On p. 37 it is stated that "most substances increase in volume on melting, but some decrease. In the case of the former the effect of pressure is to lower, in the latter to raise, the melting-point." Thomson proved the opposite of this to be the case.

The statement generally found in text-books that a ray of light passing from a rarer to a denser medium is refracted towards the perpendicular, and *vice versâ*, is reproduced on p. 42. If the authors are employing the word *dense* in the optical sense, we think they should say so, if in the ordinary sense, the statement is incorrect.

On p. 43 they describe *total reflection* as taking place when "a ray of light proceeding from a denser to a rarer medium strikes the surface, separating the two media at such an angle that the refracted ray would form a right angle (or any greater angle) with the reflected ray." We would like to know the authority for this curious statement.

On pp. 64 and 65 is a table headed "Table of Symbols, Atomic and Molecular Weights, and Valency of the Elements." It contains a list of all the elements, including those most recently discovered, norwegium amongst the rest, though the existence of the latter metal cannot be said to have been satisfactorily demonstrated. The columns to which we more particularly call attention are, however, those headed "molecular symbol, showing number of atoms in the molecule," and "molecular weight." Every element has a molecular symbol and a molecular weight assigned to it. Carbon, for instance, is represented by the molecular symbol C_2 and by the molecular weight 28. Now, on pp. 58 and 59 the reader is given to understand that the molecular weight of a substance is the specific gravity of the gas or vapour multiplied by 2 (the sp. gr. of hydrogen being taken as unity). On p. 130 it is further stated that carbon in all its forms is non-volatile. How then is the unfortunate student, or, in fact, any one else, to reconcile these statements with that found in the table that the molecular weight of carbon is 28, and what applies to this element applies of course to most of the others. We may also mention that in another part of the book (p. 160) a molecule of carbon is represented as consisting of twelve atoms. This may of course be a printer's error, but we find the same want of system in symbolic representation throughout the book.

We entirely agree with the authors that Inorganic Chemistry should receive more attention at the hands of chemists, but how is it that the authors do so little justice to what has been done in this branch of chemistry? Garzarolli-Thurnlackh's proof of the non-existence of chlorous anhydride is simply ignored, and the statements found in most text-books with reference to this imaginary compound are again reproduced. The action of nitric acid on the metals is also represented by the usual text-book equations.

A good feature in the book is the arrangement of the properties, &c., of the substances described under different headings, which are convenient for ready reference.

There are many more points to which we might refer if space allowed, but we think we have said enough to indicate that in our opinion, at least, this new manual is not calculated to supply the "want felt, but not yet satisfied."

OUR BOOK SHELF

Technical Gas Analysis. By Clemens Winkler, Ph.D. Professor in Freiberg. Translated by George Lunge, Ph.D. (London: Van Voorst, 1885.)

PROF. LUNGE has rendered another service to the world of chemists, both students and practical men, in translating Winkler's small book on "Gas Analysis." We have here a really practical work which a man may use in a works or a teacher or student in a laboratory.

Winkler's book is scarcely known in this country, and we may venture to say that several, if not most, of the gas apparatus figured and described in this book are also scarcely known.

The book is decidedly practical, and treats in the first instance of methods of collecting gases; on measurement of gases; and on apparatus and methods of analysis. The translator has added a chapter on the nitrometer, and shows how it may be used for more extended analyses than the examination of nitrous vitriol. An appendix of useful tables makes the book a very valuable laboratory companion.

Lessons in Elementary Chemistry, Inorganic and Organic. By Sir Henry E. Roscoe, LL.D., F.R.S., Professor of Chemistry in the Victoria University, Owens College, Manchester. New Edition. (London: Macmillan and Co., 1886.)

THIS favourite text-book is so well known to students of chemistry that, whilst calling attention to the appearance of a new edition, we need only remark that the author has introduced several changes and additions which bring the book as well up to date as the limits of a work of this size will permit.

LETTERS TO THE EDITOR

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

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

New System of Earthquake Observations in Japan

OWING to the invention of new seismographs by the members of the Seismological Society of Japan, there has been of late a complete change in the system of earthquake observations in this country. The Meteorological Bureau now employs the horizontal pendulum and vertical-motion seismographs of Profs. J. Milne and T. Gray, and of Prof. J. A. Ewing for systematic observation, while the Imperial University of Tokio publishes from time to time detailed accounts of particular and more interesting shocks by the use of similar instruments. These seismographs register on a revolving glass plate or drum automatically started by the earthquake motion, components of horizontal and vertical motions of the earth on a magnified scale, thus producing continuous diagrams, and indicating successive displacement of the ground in conjunction with the time.

The account of the earthquake of December 28, 1885, the largest shock during the last three months, is here given as a sample of seismic record now issued in this country. The meanings of the terms employed are as follows: a, semi-amplitude of seismic wave; T, period of complete wave; V, maximum velocity in mm. per sec., or $\frac{2\pi a}{T}$; α, maximum acceleration in mm. per sec. per sec. or $\frac{V^2}{a}$.

At the Imperial University of Tokio, Japan, at 10*h.* 6*m.* 30*s. on December* 28, 1885

Maximum semi-amplitude of horizontal motion a_1 ...	1·8
Complete period T_1 corresponding to the max. horizontal motion	1·5
Maximum semi-amplitude of vertical motion a_2 ...	0·3
Complete period T_2 corresponding to the max. vertical motion	0·6
Direction of the max. horizontal motion	E.-W.
Duration	3m. 30s.

Remarks.—The motion slowly commenced, not accompanied by quick tremors, as is usually the case. At the 14th second from the commencement a considerable E.-W. motion occurred; in another second the maximum movement appeared in the same direction, which was followed by smaller shocks during about one minute; and from thence the oscillations gradually subsided. As usual, the particles of the ground did not move to and fro, but traced a curvilinear path, although the E.-W. components always remained greater than the S.-N. components. In all, over 130 shocks or complete waves were registered.

From figures given in the above table, the maximum velocity V and the maximum acceleration α may be calculated, which are, in this case for the horizontal motion, 7·6 mm. per sec. and 39 mm. per sec. per sec. respectively. The latter quantity is the measure of the *intensity* of the earthquake, and may be employed in determining the overthrowing power of body and shattering and other destructive effects produced on buildings. Although the records given by the oscillations of fluids, fissures on walls, rattling of wine-glasses, &c., might tell something about the nature of earthquakes, and are indeed invaluable in absence of suitable instruments, yet for the *absolute* measurements of seismic force the method above cited, I believe, is by far the best that has ever been attempted on this subject.

I may add in respect to the above earthquake, and in general, that the vertical motions are always—in our experience—smaller than horizontal ones, and the maxima and minima of these two kinds of motions are not synchronous. I shall have occasion before long to communicate to you the general results of all observations made during past years.

An equally interesting set of observations carried out by the Meteorological Bureau was the determination of areas shaken in every earthquake, together with the reductions of results during the years 1885-86—the works of which I was directed to superintend. The method followed out was almost exactly the same as that originated by Prof. J. Milne in studying "387 earthquakes in North Japan," an epitome of which appeared some time ago in your columns. This method is briefly as follows. Observation-books furnished with directions for reporting earthquake phenomena with or without instruments were distributed, authorised by Government, among over 600 local offices throughout the empire; in fact, the earthquake observations were made a part of the duty of local officers, and the reports were transmitted free of postage. From the reports sent in by different observers thus closely stationed, maps have been made showing the disturbed area in every shock, and a summary of observations has been compiled.

The results worked out from a large number of these maps and their notes have revealed many interesting facts, and entirely confirmed the previous works of the eminent seismologist above mentioned.

The total number of earthquakes in Japan in 1885 was 482, equivalent to 1·3 shakings a day. In Tokio alone 68 shocks were registered. Earthquakes are most prevalent in Yezo, and the north and central portions of the main island along the eastern or the Pacific coast, but in provinces bordering the Japan Sea they are few, and in some places none at all; if they occur, they are generally limited to small tracts of land. Speaking of the main island in general, the range of mountains traversing through and forming the backbone of Central Nippon appears to divide it into two zones of different seismatic activities. In Kiushū, Shikoku, and other islands, disturbances are comparatively small.

Most larger earthquakes originate beneath the ocean. The majority of shocks are only local. Of the whole number, 235 local disturbances were recorded, which have not extended more than 100 square miles of land area. The maximum area of *one* earthquake was 34,700 square miles. The aggregate area of disturbance during the year was 796,000 square miles, and taking the total area of the empire to be 147,000 square miles, it is equivalent to saying that the whole of Japan has been shaken 5·4 times in one year. In summer shocks are less prevalent than in winter. The earthquakes occur in groups, that is to say, when disturbances occur, they are limited within certain portions of country, not generally extending beyond these limits. Propagations of seismic waves are often stopped by mountain-chains.

Finally, I may state that we shall continue these observations in future, and I hope the results to be obtained from more years' work of this nature will be some help in throwing light on the physics of the earth's crust. SEIKEI SEKIYA

The Imperial University of Tokio, Japan, February 28

"The Krakatão Dust-Glows of 1883-84"

IN your issue of March 25 (p. 483) the writer of the critical notice of Dr. Riggenbach's pamphlet on the above propounds a statement which, if true, is of vast importance in accounting for the subsequent optical phenomena which are supposed to have been connected with the eruption. He says: "Thus the hurling into the air of 150 cubic kilometres of volcanic dust in August 1883," &c. Whence does he deduce this enormous quantity? M. Verbeek, in his "Krakatão," part 1, which I have carefully perused, estimates the entire volume of ejecta (chiefly based on what fell near the spot) at only 18 cubic kilometres, and as his work is the only reliable source of information regarding the eruption with which I am acquainted, I am entirely at a loss to conceive how the 18 has been suddenly magnified into 150.

As one of the Krakatão Committee of the Royal Society, I have naturally examined the theoretical possibility of the amount of dust ejected having been sufficient to account for the optical phenomena witnessed, and have been obliged to content myself with the very modest quantity of 4 cubic kilometres out of the total 18, but if your writer's statement is correct, I am evidently at liberty to considerably augment the quantity at my disposal, and it is needless to say that this would seriously change the aspect of the question. E. DOUGLAS ARCHIBALD

April 15

Pumice on the Cornish Coast

Is Mr. Guppy sure that the "pumice" he records in NATURE for April 15 (p. 559), as found on Maenporth Beach, is the natural article? I ask because of having been accustomed to find pieces of a pumice-like stone, many light enough to float on the sea, along the Suffolk coast. This, however, is an artificial product, a sort of cinder from steamers, though it has deluded many people. It puzzled me for some time.

W. WHITAKER

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Ferocity of Animals

IF your correspondent in last week's NATURE (p. 583) will treat a wild rat in the way which I described, the animal will answer his question much more effectually than I can. For while I have only words at my disposal whereby to convey any "ejective" information upon the subject, the rat will display the fact of his understanding your correspondent's intention by a thousand co-ordinated movements of a much more eloquent kind.

The paper by Mr. Lloyd Morgan in the current issue of *Mind* is merely a republication of his views as already presented in this periodical. Having replied to these views as fully as seemed to me desirable when they were first expressed, it is needless that I should now go over the same ground a second time. It will, therefore, be sufficient to refer your correspondent to the discussion between Mr. Morgan and myself, which he will find in consecutive issues of NATURE for February and March 1884.

GEORGE J. ROMANES

The Climbing Powers of the Hedgehog

I REMEMBER many years ago we kept a hedgehog on the Continent in an upper garden well walled in. There she remained for some time, until she littered four or five young in a rubbish heap in a corner. The young having grown, and being able to move about, she and her whole brood disappeared. Her only way was over a wall four or five feet high, on which she left traces, but the young could not have been able to climb this, and she must have carried them. HYDE CLARKE

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ON THE LAW OF THE RESISTANCE OF THE AIR TO THE MOTION OF PROJECTILES

IN my experiments made to determine the resistance of the air to the motion of projectiles, it was assumed that this resistance followed *some law* producing a gradual change in the velocity, and consequently that the times occupied by the shot in passing over a succession of equal spaces would admit of being differenced. This method of proceeding gave the required result in the form of a coefficient K_v of v^3, in terms of the second and higher differences of time above referred to, when the time was expressed in seconds to five places of decimals. So long as this value of K remains constant, the resistance of the air varies as the *cube* of the velocity The first results obtained were published in a note in the *Phil. Trans.* for 1868, p. 441. The experiments were afterwards more carefully calculated, and given in detail in the Reports published by Government in 1870. In using these results to calculate general tables for space and time, for cases where the projectile could be supposed to move approximately in a straight line, and free from the action of gravity, the corrected mean values of K_v were used, and made to vary with the corresponding velocity v. And in my "Treatise on the Motion of Projectiles" (1873), the *cubic* law of resistance was used for the purposes of calculation, so that for those velocities where K varied it was necessary to divide the trajectory into such small arcs that, throughout each arc, the average value of K could be used without sensible error. This treatment of the question rendered it unnecessary for me to attempt to express the law of resistance according to powers of v for all practical velocities. But from the results of my experiments for velocities between 900 and 1700 f.s., I remarked that "the resistance of the air may be considered to vary roughly as the *sixth* power of the velocity for velocities 900–1100 f.s., to vary as the *third* power for velocities 1100–1350 f.s., and to vary as the *second* power for velocities above 1350 f.s. (*Proc.* R.A. Inst., September 1871).

Further experiments were made in 1878–80, which furnished the values of K for velocities from 100 to 2800 f.s., as published in Reports, 1879 and 1880.

I now propose to express the resistance of the air to the motion of ogival-headed shot ($1\frac{1}{2}$ diam.) in terms of v^2, v^3, and v^6, according to the values of v. The Newtonian law of retardation is given by $-\frac{d^2}{w}k\left(\frac{v}{1000}\right)^2$; the cubic law by $-\frac{d^2}{w}K\left(\frac{v}{1000}\right)^3$; and the law of the 6th power by $-\frac{d^2}{w}L\left(\frac{v}{1000}\right)^6$, where d denotes the diameter of the shot in inches, and w its weight in pounds. The values of K_v used in the tables given below (I. to V.) are those given directly by experiment, as published in my Reports of 1870 and 1880, with the exception that the values of K_v for velocities between 1080 and 1580 f.s. have been increased by 0·68 per cent., to render the density of the air uniform throughout.

The points of division in these tables are somewhat arbitrary, and if they should be passed a little either way the practical error will not be large. Capt. Ingalls, of the U.S. First Artillery, has deduced very similar coefficients from my experiments, which he has published in his "Exterior Ballistics" (1885).

In another place I have shown (*Proc.* of the R.A. Inst., 1885) how K may be corrected: (1) for density of the air, by the introduction of a factor τ; (2) for steadiness of the shot by a factor σ; and (3) for a different form of head, by a factor κ. The corrected value of K thus becomes $K\tau\sigma\kappa$. And the same form of correction will apply to the coefficients k and L.

It must be remarked that the values of K for high velocities were derived from the motion of shot fired at low elevations. Consequently, in calculating ranges for comparison with experimental ranges, &c., the best agreement may be expected for low elevations of 1° to 4° or 5°. But when the muzzle velocity is high and the elevation considerable, there are several disturbing causes to be considered.

The elongated projectile has a tendency to preserve the parallelism of its axis, but this soon becomes inclined to the direction of motion of its centre of gravity, and hence arises a lateral pressure from below, which gives rise to a gyratory motion of the shot. The effect of this upon the shot is to increase the resistance of the air; to give a lateral "drift," and probably a still greater vertical "drift," because the *first* lateral disturbing pressure is from below.

When the projectile rises to a great height the density of the air decreases, and the resistance of the air is consequently diminished.

The direction of the initial motion of a shot is commonly not that in which the gun is pointed, but is affected by an error called the "jump."

All these errors tend generally to increase the range, except that, when the axis of the shot is oblique to the direction of motion, the resistance is increased. But it is evident that the direction of the axis of the shot does not differ much from the direction of the tangent to the trajectory, because the holes made in targets appear practically circular.

And, further, guns have different shooting qualities, and t is said that two guns of the same type do not shoot alike. One gun may be superior to another for one charge and be inferior for a different charge, as our experiments clearly showed. I mention these matters to show that we cannot expect an *exact* agreement in all cases between calculation and experiment.

TABLE I.—RESISTANCE $\propto v^2$

v f.s.	Experimental K_v	$\frac{vK_v}{1000}=k_v$	Error	v f.s.	Experimental K_v	$\frac{vK_v}{1000}=k_v$	Error
430	132·9	57·1	− 4·2	670	100·2	67·1	+ 5·8
440	132·9	58·5	− 2·8	680	98·4	66·9	+ 5·6
...	...	...	...	690	96·9	66·9	+ 5·6
460	138·2	63·6	+ 2·3	700	87·7	61·4	+ 0·1
470	147·0	69·1	+ 7·8	710	81·8	58·1	− 3·2
480	164·6	79·0	+17·7	720	83·6	60·2	− 1·1
...	...	...	...	730	72·8	53·1	− 8·2
530	117·2	62·1	+ 0·8	740	78·8	58·3	− 3·0
540	113·1	61·1	− 0·2	750	83·1	62·3	+ 1·0
550	109·5	60·2	− 1·1	760	83·9	63·7	+ 2·4
560	97·4	54·5	− 6·8	770	85·7	66·0	+ 4·7
570	101·9	58·1	− 3·2	780	81·0	63·2	+ 1·9
580	95·9	55·6	− 5·7	790	72·1	57·0	− 4·3
590	109·0	64·3	+ 3·0	800	61·4	49·1	−12·2
600	111·6	67·0	+ 5·7	810	60·7	49·1	−12·2
610	107·6	65·6	+ 4·3	820	66·5	54·5	− 6·8
...	...	..	...	830	75·5	62·7	+ 1·4
650	94·5	61·4	+ 0·1	840	75·1	63·1	+ 1·8
660	97·0	64·0	+ 2·7	850	70·7	60·1	− 1·2

Mean value of k = 61·3 for velocities under velocity 850 f.s.

As it was impossible to carry out experiments for velocities below 430 f.s. in the usual way, special experiments were made with elevations of 45° and muzzle velocities 420–140 f.s. The ranges and times of flight were calculated on the supposition that the above law held for velocities below 430 f.s. (Final Report, pp. 7, 48, 49). As the agreement between calculation and experiment was satisfactory, it was concluded that the above found law was good for velocities 100 to 850 f.s.

TABLE II.—RESISTANCE $\propto v^3$.

v f.s.	Experimental K_v	Error	v f.s.	Experimental K_v	Error
850	70·7	−3·7	950	76·1	+1·7
860	68·6	−5·8	960	73·8	−0·6
870	65·2	−9·2	970	73·6	−0·8
880	65·7	−8·7	980	73·5	−0·9
890	75·3	+0·9	990	74·6	+0·2
900	81·6	+7·2	1000	74·6	+0·2
910	79·7	+5·3	1010	74·6	+0·2
920	77·6	+3·2	1020	74·2	−0·2
930	76·3	+1·9	1030	75·1	+0·7
940	73·3	−1·1	1040	84·0	+9·6

Mean value of K = 74·4 between velocities 850 and 1040 feet per second.

TABLE III.—RESISTANCE $\propto v^6$.

v f.s.	Experimental K_v	$\left(\frac{1000}{v}\right)^3 K_v = L_v$	Error
1040	84·0	74·7	−4·5
1060	92·1	77·3	−1·9
1080	106·0	84·1	+4·9
1100	107·2	80·5	+1·3

Mean value of L = 79·2 between velocities 1040 and 1100 feet per second.

TABLE IV.—RESISTANCE $\propto v^3$.

v f.s.	Experimental K_v	Error	v f.s.	Experimental K_v	Error
1100	107·2	−1·6	1220	110·3	+1·5
1120	105·0	−2·8	1240	108·7	−0·1
1140	109·0	+0·2	1260	109·4	+0·6
1160	109·7	+0·9	1280	111·2	+2·4
1180	109·5	+0·7	1300	109·3	+0·5
1200	106·5	−2·3			

Mean value of K = 108·8 between velocities 1100 and 1300 feet per second.

TABLE V.

v f.s.	Experimental K_v	$\frac{vK_v}{1000} = k_v$	Error	v f.s.	Experimental K_v	$\frac{vK_v}{1000} = k_v$	Error
1300	109·3	142·1	+0·6	2120	67·6	143·3	+ 1·8
1320	108·0	142·6	+1·1	2130	67·8	144·4	+ 2·9
1340	106·3	142·4	+0·9	2140	67·5	144·5	+ 3·0
1360	105·6	143·6	+2·1	2150	67·5	145·1	+ 3·6
1380	105·9	146·1	+4·6	2160	67·1	144·9	+ 3·4
1400	105·0	147·0	+5·5	2170	67·0	145·4	+ 3·9
1420	104·4	148·2	+6·7	2180	67·0	146·1	+ 4·6
1440	103·2	148·6	+7·1	2190	67·0	146·7	+ 5·2
1460	101·2	147·8	+6·3	2200	66·9	147·2	+ 5·7
1480	99·1	146·7	+5·2	2210	66·9	147·8	+ 6·3
1500	98·0	147·0	+5·5	2220	66·9	148·5	+ 7·0
1520	94·7	143·9	+2·4	2230	66·9	149·2	+ 7·7
1540	93·0	143·2	+1·7	2240	66·9	149·9	+ 8·4
1560	92·7	144·6	+3·1	2250	66·8	150·3	+ 8·8
1580	91·9	145·2	+3·7	2260	66·8	151·0	+ 9·5
1600	90·4	144·6	+3·1	2270	66·8	151·6	+10·1
1610	89·2	143·6	+2·1	2280	67·7	154·4	+12·9
1620	87·9	142·4	+0·9	2290	66·9	153·2	+11·7
1630	86·7	141·3	−0·2	2300	66·9	153·9	+12·4
1640	84·1	137·9	−3·6	2310	67·0	154·8	+13·3
1650	84·2	138·9	−2·6	2320	66·1	153·4	+11·9
1660	84·6	140·4	−1·1	2330	64·4	150·1	+ 8·6
1670	84·9	141·8	+0·3	2340	64·6	151·2	+ 9·7
1680	85·1	143·0	+1·5	2350	64·6	151·8	+10·3
1690	84·8	143·3	+1·8	2360	64·6	152·5	+11·0
1700	84·5	143·7	+2·2	2370	63·8	151·2	+ 9·7
1710	84·8	145·0	+3·5	2380	63·7	151·6	+10·1
1720	82·8	142·4	+0·9	2390	61·0	145·8	+ 4·3
1730	81·5	141·0	−0·5	2400	59·8	143·5	+ 2·0
1740	80·1	139·4	−2·1	2410	59·2	142·7	+ 1·2
1750	78·3	137·0	−4·5	2420	57·1	138·2	− 3·3
1760	78·3	137·8	−3·7	2430	57·1	138·8	− 2·7
1770	80·5	142·5	+1·0	2440	54·5	133·0	− 8·5
1780	79·7	141·9	+0·4	2450	52·8	129·4	−12·5
1790	79·2	141·8	+0·3	2460	52·2	128·4	−13·1
1800	78·8	141·8	+0·3	2470	52·2	128·9	−12·6
1810	74·7	135·2	−6·3	2480	52·3	129·7	−11·8
1820	74·9	136·3	−5·2	2490	52·3	130·2	−11·3
1830	74·7	136·7	−4·8	2500	52·3	130·8	−10·7
1840	74·7	137·4	−4·1	2510	52·4	131·5	−10·0
1850	74·7	138·2	−3·3	2520	52·4	132·0	− 9·5
1860	74·5	138·6	−2·9	2530	52·5	132·8	− 8·7
1870	72·3	135·2	−6·3	2540	52·6	133·6	− 7·9
1880	73·3	137·8	−3·7	2550	52·6	134·1	− 7·4
1890	74·5	140·8	−0·7	2560	52·7	134·9	− 6·6
1900	71·5	135·9	−5·6	2570	52·7	135·4	− 6·1
1910	71·6	136·8	−4·7	2580	53·4	137·8	− 3·7
1920	69·9	134·2	−7·3	2590	53·5	138·6	− 2·9
1930	69·5	134·1	−7·4	2600	53·6	139·4	− 2·1
1940	69·0	133·9	−7·6	2610	53·6	139·9	− 1·6
1950	69·4	135·3	−6·2	2620	53·7	140·7	− 0·8
1960	69·6	136·4	−5·1	2630	53·8	141·5	0·0
1970	69·2	136·3	−5·2	2640	51·5	136·0	− 5·5
1980	68·4	135·4	−6·1	2650	52·1	138·1	− 3·4
1990	68·2	135·7	−5·8	2660	52·0	138·3	− 3·2
2000	68·3	136·6	−4·9	2670	52·0	138·8	− 2·7
2010	68·3	137·3	−4·2	2680	52·0	139·4	− 2·1
2020	68·4	138·2	−3·3	2690	52·0	139·9	− 1·6
2030	68·2	138·4	−3·1	2700	51·9	140·1	− 1·4
2040	68·5	139·7	−1·8	2710	51·9	140·6	− 0·9
2050	68·4	140·2	−1·3	2720	51·9	141·2	− 0·3
2060	67·7	139·5	−2·0	2730	51·9	141·7	+ 0·2
2070	67·8	140·3	−1·2	2740	51·9	142·2	+ 0·7
2080	68·0	141·4	−0·1	2750	51·9	142·7	+ 1·2
2090	68·2	142·5	+1·0	2760	51·9	143·2	+ 1·7
2100	67·9	142·6	+1·1	2770	52·5	145·4	+ 3·9
2110	67·8	143·1	+1·6	2780	52·5	146·0	+ 4·5

Mean value of $k = 141·5$ for velocities 1300 to 2780 feet per second.

I have recently calculated some ranges of elongated shot for low elevations, starting with a m.v. of 1900 f.s., allowing 6′ for "jump." The following are the results obtained:—

Elevation	1°	2°	3°	4°	
Experimental range...	1086	1811	2400	2917	yards
Calculated range ...	1049	1814	2392	2896	,,
Difference ...	−37	+3	−8	−21	,,

In the Final Report (pp. 43-45) will be found calculated ranges for comparison with range tables, both English and German, for upwards of 120 ranges fired with muzzle velocities below 800 f.s. Taking the best of the English comparisons where the m.v. was 751 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	35°	
Exp. range...	978	1788	2467	3000	3467	3813	4000	yds.
Calc. ,, ...	973	1780	2462	3027	3473	3804	4013	,,
Difference ...	−5	−8	−5	+27	+6	−9	+13	,,

The worst was for a m.v. of 628 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	35°	
Exp. range...	691	1236	1767	2231	2683	3017	3194	yds.
Calc. ,, ...	698	1290	1805	2242	2593	2858	3037	,,
Difference ...	+7	+54	+38	+11	−90	−159	−157	,,

The best German comparison was with a m.v. of 705·4 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	
Exp. range...	875	1598	2221	2729	3139	3452	yds.
Calc. ,, ...	867	1591	2214	2730	3143	3449	,,
Difference ...	−8	−7	−7	+1	+4	−3	,,

The worst was for a m.v. of 774·3 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	
Exp. range...	1020	1900	2659	3274	3745	4130	yds.
Calc. ,, ...	1028	1878	2590	3181	3641	3987	,,
Difference ...	+8	−22	−69	−93	−104	−143	,,

The calculations were all made for the English projectiles where $d^2 \div w = ·5616$, while for the German projectiles $d^2 \div w = ·5785$. If the latter value could have been conveniently used for the German ranges, &c., the calculated ranges would have been slightly reduced, which would generally have given a still better agreement between experiment and calculation.

Since the publication of my Final Report (1880) several pamphlets treating of the resistance of the air have been issued from the private printing press of M. Krupp. The main object seems to have been to persuade the world that the Krupp system entails a lower resistance to the shot than that encountered by the English system. The difference, if any, appears due to the more pointed form of the Essen projectile, and to the lower density of the air adopted. In general no sufficient explanation is given of the particulars of the experiments made. But in the paper (xxx.) some details have been furnished of experiments undertaken at Meppen (1881) to try whether the resistance of the air varied as the square of the velocity for velocities above 400 m.s. Supposing this to be the case, an expression was found for λ the coefficient of resistance in terms of the velocities of the shot at two points in its course, the distance between them, &c.

Six chronoscopes were distributed in pairs—one pair being placed at *A*, 30 metres from the gun; another pair at *B*, 130 metres from the gun; and the remaining pair at *C*, 500, 1000, &c., metres from the gun. The experiments were arranged in groups. We will examine group 3, formed of rounds 7, 8, 9, and 10. The mean velocity at *A* was stated to be 900·1 m.s.; at *B*, 853·2 m.s.; and at *C*, 438·1 m.s. Taking the range *A C*, the value of $\lambda 10^6$ was found 3·585; and the range *B C* gave 3·700; so that the mean of the two was 3·64. The mean value of $\lambda 10^6$ finally adopted was 3·66, differing very little from the above result.

But if we examine the matter more closely we find that the velocities for round 9, given by the two chronographs at *A* were 907·4 and 887·2 m.s., showing a difference of 20·2 m.s., or 66·3 f.s.; and for round 10 there was a difference in the measured velocities at *B* of 19·4 m.s., or 63·6 f.s.; while at *C* there was only *one* velocity measured for all four rounds, by one instrument; so that the determination of the value of λ in both the above cases was made to depend upon one solitary velocity, measured by an instrument manifestly unreliable. But at both *A* and *B* the velocity adopted was an average of the results of eight measured velocities. Consequently these velocities at *A* and *B* may be expected to give a trustworthy value of λ over range *A B*, if the experiment be of any importance. Substituting we find $\lambda 10^6 = 2·58$, something very different from its adopted value 3·66. So that, according to this group 3, the Newtonian law of resistance holds for velocities between 900 and 438 m.s., and for velocities between 853 and 438 m.s., but not for velocities between 900 and 853 m.s.! Group 2 is still more inconsistent.

Gen. Mayevski is also the author of an attempt to express the laws of the resistance of the air to elongated projectiles from extensive experiments said to have been made at Meppen in 1881. The projectiles were more pointed, and the standard density of the air adopted was less than those used in England. Capt. Ingalls, having reduced Gen. Mayevski's coefficients to English measures for convenience of comparison, remarks, "It will be seen that these coefficients are less than the corresponding coefficients derived from Bashforth's values of *K*, given above. This is undoubtedly due to the different forms of projectiles used in the two series of experiments, and particularly to the difference in the shapes of the heads" (p. 21). My values of *K* were derived from about 350 rounds, each of which in general furnished from 8 to 10 *consistent* records, and gave numerous values of *K* by the help of a single chronograph. And the values of *K* used in the above tables are the means of 40, 30, 20, 10, &c., independent determinations of *K* for each velocity. Beyond a doubt they express accurately the average results of the rounds fired.

Although the shooting of recent guns is said to have been improved, it is doubtful whether the coefficients of resistance will require any sensible reduction on that account for long ranges. For, as we have seen, however steady may be the initial motion of an elongated shot, the lateral action of the air must soon set up a gyratory motion of the shot, and therefore the axis of the shot must become oblique to the direction of motion. And we are told that a slight initial unsteadiness of the shot becomes corrected, so that it steadies down in its flight. This we might expect from the nature of the action of the air on an elongated projectile rotating about its axis, which tends to place the axis approximately in the direction of the motion of the shot. But, if it should be found necessary to reduce the coefficient of resistance, this, as I have said, can be effected by writing $K\sigma$ instead of K, where σ is less than 1. But inasmuch as we have to use $\frac{d^2}{w} \times K\sigma = \frac{d^2}{w}\sigma \times K$, we must first calculate the value of $\frac{d^2}{w}\sigma$, and then use the tabular numbers in the usual manner.

F. BASHFORTH

PLANTS CONSIDERED IN RELATION TO THEIR ENVIRONMENT

THAT great differences of constitution are to be found among plants is at once evident—differences affecting internal structure, external form, and habit of life. Those of structure and form at first seem likely to be correlated, and no doubt such relation to a large extent does obtain, but still it is not at all exact, differences of form occurring between plants whose internal structure closely agrees. The study of the environment of the particular plant enables us to see that this must be taken into account in tracing the changes that have made it what it is, each plant having a power of adaptation to circumstances which determines the form which it assumes, which modifies, though with extreme slowness, its internal structure, and which leads in course of time to the recognition of new species.

Looking at plants from this point of view, we notice at once great differences between those which flourish in water and those whose home is on land. These, again, show diversities between those whose habit is terrestrial and those which are epiphytic, while others are noticeable whose habit of life is more or less completely parasitic, and whose constitution and structure are much modified in consequence.

A typical land plant will be seen to consist of a stem, branching continually, bearing a variable but usually very large number of leaves, and continuous below with a root or system of roots embedded in the soil. The stem will be characterised by a great development of wood, rigidity being thus secured. The leaves will be noticeable especially for their great extent of surface in relation to their bulk, and will show, generally on their under surfaces, though very frequently on both, a large number of stomata. The roots will be woody, like the stem, and towards their ultimate terminations will be found to bear a varying number of delicate root-hairs, by means of which they are enabled to discharge their special function of absorption of water.

This plan of construction is considerably deviated from by plants whose habit is aquatic. The stiffness so essential to a land plant, which has to resist storms of wind, is not at all essential to a water one, which has rather to adapt itself to varying currents of water. More flexibility, and that of a rather different kind, is needed by the stem. We find, consequently, that the rigidity of an aquatic plant is mainly arrived at by the development of turgid parenchymatous tissue containing typically large intercellular spaces, while the woody tissue largely disappears. The intercellular spaces in most cases form a very elaborate system, as may be seen on examining the petioles of the large white water-lily (*Nymphæa alba*), the stem of the common mare's-tail (Hippuris), or the whole plant of different species of Potamogeton. The number of the fibro-vascular bundles is much less than would be the case in the stem of a land plant of similar dimensions, but the most noticeable difference is the relatively much smaller amount of woody tissue in each bundle. This difference of internal constitution may be connected also with a functional difference associated with the environment. The woody tissue of a plant is concerned with the transmission of water upwards from the roots to the leaves. In the case of an aquatic plant this is not needed to anything like the extent to which it is in an ordinary tree, and hence a further reason for the disappearance of woody elements. Nor is it only the stem which has been affected by the habitat. The character of the root will be found to vary. This is best seen in noticing the effect of allowing the root of an ordinary land plant to come into contact with a quantity of water. By its constitution it is fitted to absorb only the hygroscopic water surrounding particles of soil. The first effect of the contact with excess of water is to cause the root to perish; but after a time new roots are developed which can utilise the moisture they now are in contact with, and which in turn are unable to avail themselves of the hygroscopic water which before was necessary. Both kinds of roots may be seen sometimes on plants which have been growing close to pipe-drains, some having penetrated the drain, and so come into contact with water in quantity; others remaining unchanged, and utilising only the water of the soil. Such differences may be noticed also in the case of hyacinths, grown some by water culture in glasses, others in ordinary earth. The former roots are larger and more succulent than the latter. A difference also may be seen in the development of the root-hairs, though a very definite statement about this can hardly be made. Still, in allied species, and often in individuals of the same species, the hairiness of the roots increases with increasing sunlight, dryness, and airiness of the spot in which the plants are growing.

The leaves also undergo much structural modification. Many plants have leaves which are totally submerged, and these are able to resist the action of the water, which would soon destroy ordinary leaves, whose constitution fits them to live only in air. Some amphibious plants show this peculiarity well. They grow generally in marshy places, or on the banks of streams, by which they are often submerged. Such a plant, having its land form, possesses leaves which die on being submerged, but later it puts out other leaves which are not injured. In *Lycopus europæus* and in *Lythrum Salicaria* there is also a histological difference between the stems grown in water and those grown in air. Two layers of cells containing no chlorophyll are developed in the watery specimens deep down in the cortical parenchyma The outer layers of tissue perish, and these new cells then serve to protect the tissues within. In the leaves of water plants also, other peculiarities are noticeable. Generally chlorophyll is developed in the epidermis, a fact which is perhaps connected with the slight amount of evaporation taking place The position of the stomata and their relative number in different cases is also closely connected with their habit of life. This may be well seen in Marsilea, whose leaves, though generally raised above the surface of the water, are sometimes to be found floating on the surface. The aërial leaves have stomata on both upper and under surfaces, but the swimming ones have them only on the upper surface, and have then three times the number that the same surface of the aërial leaf possesses. It is easy to show that the change is the result of the change in the environment, for if a piece of the plant, possessing quite young leaves, be submerged and kept under the surface, the young leaves will develop into swimming-leaves, and not aërial ones. In other water plants with large floating leaves the same disposition of stomata may be seen. Generally on sub-aërial leaves it is the lower surface which shows them in far the larger quantity. The environment of the plants then seems to have a great influence on their distribution, that arrangement being followed which is best suited to keep the stomata dry.

A curious adaptation of structure to environment is seen in the roots of the epiphytic orchids and aroids. These are aërial in habit, hanging freely downwards. Not coming into contact with water in the same way as either aquatic or terrestrial plants, they have no root-hairs. There is a development of tissue met with in them which enables them to absorb and avail themselves of the moisture in the atmosphere. Instead of the usual single-layered epidermis, they are covered by a many-layered velamen made up of numerous cells fitting closely together, of the description known as tracheïdes. The usual cuticle or secretion from the outer walls of the epidermis, which is always very little developed in roots, is here altogether absent; the membranes of the cells are usually colourless, and the cells themselves contain air. This layer absorbs water quickly, supplying the plant with moisture.

The influence of the environment on the forms of leaves, as well as on their structure, can be well seen also in aquatic plants. The swimming-leaves show certain general resemblances, their form being more or less rounded, and not as a rule lobed or cut; they are, too, usually of fair dimensions. In the case of submerged leaves we find differences which are connected with the conditions noticeable in the water. Thus, in a rapid stream they are generally long and very much divided, while in stagnant water this is not the case. Three species of the genus Ranunculus especially exhibit a gradation in this respect. *R. divaricatus* is a denizen of stagnant water; *R. aquatilis* is found in slowly-flowing streams; *R. fluitans* in rapid ones. The divisions of the leaf are longest in the last case and shortest in the first, the second being intermediate. *R. aquatilis* is an amphibious form, and shows well how environment decides the character of the adult plant. When growing in a pool it has its leaves in fairly long divisions, the lobes being rounded and the internodes long. If the pool should dry up, it changes gradually, the new leaves being less divided and the divisions becoming flattened, while the nodes are nearer together. The epidermis, which in the water form had almost square walls, now becomes serpentine. Growing so, it produces in due time its flowers and seeds, and these latter reproduce the land form. If the pool again becomes filled with water, a reversion speedily takes place, and again the characteristics of the water form are seen. The two are, in fact, easily converted from the one into the other.

Not only is the correspondence between environment, form, and structure seen in the species of Ranunculus already alluded to, but the whole genus can be divided into two sections, those of terrestrial and those of aquatic habit, so nearly allied to each other in all points of so-called systematic importance that they are now included together under the common name Ranunculus, and yet extremely dissimilar in form and structure of the vegetative parts. The same difference in amount of woody tissue as has been alluded to above can be seen most strikingly by comparison of sections of the stem of *R. repens* with those of the stem of *R. fluitans*.

Turning now from aquatic plants to those which, though alike terrestrial, are yet situated amid very different surroundings, the effect of the environment can easily be traced. Take, first, the plants which inhabit regions in which habitually the air contains very little moisture. These may be affected in several different ways—the most conspicuous modification perhaps being the different forms of succulent plants, such as *Mesembryanthemum*. In these the leaves have lost the usual ratio between surface and bulk; they are now thick and fleshy, their internal parenchyma being very succulent or pulpy; their outer layers leathery, with comparatively few stomata, and a great reduction of the system of intercellular spaces typically found in the leaf. Their environment has led to such a structure as will enable them to make the most of the limited supply of moisture, great facilities being seen for storing it, and precautions taken against its escape. Similar adaptations, but affecting the stems and not the leaves, are found, *e.g.*, in the branching, fleshy Opuntias, while we have also large, thick, fleshy leaves in the aloes and agaves of such regions. The genus Euphorbia has some strange representatives here. There are several hundred species of this genus, inhabiting all parts of the world, and all characterised by the peculiar structure of the flower familiar to us in the common spurge of our gardens. The great majority of the species are annual or perennial herbs, with slender unarmed stems bearing great numbers of scattered, sessile, simple leaves. The comparatively few members of the genus which inhabit the regions of little moisture have become so extremely modified in their vegetative parts as to closely resemble cactuses. *E. canariensis* especially has taken on this peculiar habit, developing enormously its stem and branches, the former becoming in some cases 20 feet high, and ceasing to produce leaves, while the branches are plentifully supplied with prickles.

A curious modification in the cells of the leaf is seen sometimes in some species of Oxalis. In plants grown in well-shaded spots the cells of the pallisade parenchyma are not so much elongated as in those exposed to more light, but are more conical. In the beech too a similar difference is noted. In the sun the leaf is smaller and thicker, and has several layers of pallisade parenchyma, while in the shade it is large, but thin, and the pallisade layer is single.

Looking still at terrestrial plants, the general character of the vegetation in different regions illustrates well the general correspondence between environment and structure. In the tropics we find vegetation luxuriant, huge trees with evergreen leaves, masses of interlacing climbers, a great tendency of the smaller plants to become shrubby, even some annuals simulating the bushes of temperate regions; the presence of palms, tree-ferns, &c. Higher in latitude these disappear, bushes are more numerous; the trees become less luxuriant and more compact, the leaves smaller and more rigid; annuals are found in larger proportion, while mosses and lichens make their appearance. Still higher, where the influence of winter begins to be felt, the trees have as a rule deciduous leaves, which do not cover them for more than half the year. Where the leaves remain evergreen, as in the Coniferæ, they are specially constructed to resist cold, being strongly cuticularised and altered in form so that the ratio of surface to bulk is much lessened. In the pines especially they are much elongated, becoming almost needle-like in shape. Their structure is adapted especially to check loss of water by evaporation, and to protect the delicate parenchyma of the interior from the access of the cold.

Various modifications of structure accompany also a parasitic habit of life. Here the effect of the environment must be taken to include all the various interferences with the normal habits of plants brought about by the changes in the mode of nutrition which the parasite now pursues. The modifications will be seen to be greater the more complete the parasitism. We may consider what are perhaps the most striking cases, those found among flowering plants. Of these we have certain Scrophulariaceæ which show but little modification. They take only part of their nourishment from their hosts, being furnished with means of living exactly like other plants. The dependence of the different species of Orobanche on the host is more complete. The outward form of the plant is there; the long stem, bearing small leaves. In accordance with the mode of nutrition, all the food being absorbed from the host, the power of absorbing food or obtaining energy from without the latter has gone; the leaves contain no chlorophyll, and are consequently brown and shrivelled. In Cuscuta the process of degradation has gone still further, even the leaves having disappeared. The degradation does not affect merely the vegetative structure, but the reproductive organs also suffer, as may be seen in the common mistletoe. This change, however, seems only incidentally to be connected with the environment, being rather the result of the disturbance of the constitutional equilibrium brought about by the changes in nutrition.

A comparison of lower forms of parasitic habit with others which, though about as high in the scale, do not depend on a host for support, reveals similar degradation brought about by the nature of the mode of life. Their power of independent growth has much decreased, their cells often appear to contain no nuclei, or these are made out with difficulty; they have no chlorophyll, nor any of the other colouring matters which are present in the non-parasitic forms.

Some curious modifications of structure are associated also with different climbing plants. These are not of so general a nature as those already alluded to, being noticeable only on particular species. In *Ampelopsis hederacea*, and in *A. Veitchii* the curved tips of the tendrils, after touching a surface, form adhesive disks, which secrete and pour out a resinous cement which attaches the tendril to the surface. *Bignonia capreolata* has a similar but more elaborate development, while *Ficus repens*, which climbs like the ivy by rootlets, exudes similar material from its rootlets, this being somewhat of the nature of caoutchouc.

Not only the vegetative parts of plants thus exhibit modifications of structure according to the nature of their environment, but the same thing can be seen especially with regard to the structure of the reproductive organs. The ways in which these are adapted to different modes of fertilisation would however pass far beyond the limits of this article.

NOTES

PROF. MELSENS, the distinguished chemist, has died at Brussels, at the age of seventy-two.

BY the death of the Rev. W. W. Newbould, F.L.S., which took place on April 16, at Kew, at the age of sixty-seven, a figure has passed away very familiar to the frequenters of the meetings and library of the Linnean Society, the British Museum herbarium and reading-room, and the herbarium at Kew. At the time of his student-days at Cambridge, where he was a pupil of Prof. Henslow, Mr. Newbould acquired a love of botany, which became the recreation, and latterly the pursuit, of his life. His interest was, however, confined to a study of our native British plants, the limitation of the species, and especially their geographical distribution. Several of our local county floras owe much to his co-operation; and of some particular groups of plants he had a very exact knowledge. But his speciality was an intimate acquaintance with the botanical bibliography of this country; in his knowledge especially of the older literature he was almost unrivalled.

MANY will regret to learn of the death of Thomas Edwards, the Banff naturalist, so well known through his Life by Mr. Samuel Smiles. Edwards was born on Christmas Day, 1814, at Gosport, Portsmouth, where his father, a private in the Fifeshire Militia, was stationed after returning from the Peninsular War. Early in life Thomas Edwards showed indications of a great love of animals, insects, and creatures of every description. He made extensive excursions in search of specimens, and many amusing anecdotes are told to illustrate his extreme fondness for even the most repulsive subjects in the animal creation. At eleven he was apprenticed to a shoemaker, and at the age of eighteen he had undergone many severe trials. He joined the Militia, but his love of insects proved fatal to his military ambition. In his twentieth year Edwards went to work as a shoemaker at Banff, and there he pursued so successfully his researches in natural history that he added a great deal to his scientific store of knowledge. For fifteen years he carried on the most of his researches by night, and he had many narrow escapes by reason of the eagerness with which he pursued his object. He completed, however, a splendid collection, and in 1846 exhibited it in Aberdeen. The exhibition was a failure, and he had to sell the collection for 20*l*. to defray the expenses. He then set to work to form another collection, and was most successful. His researches added greatly to the knowledge of natural history, as he embodied his new discoveries in papers written to scientific magazines. In 1866 Edwards was elected a member of several scientific societies. Latterly he had acted as Curator of Banff Museum. After the publication of his biography by Smiles, Edwards's genius was publicly recognised by a presentation of 333*l*. made to him in Aberdeen, and he was awarded by the Queen a pension of 50*l*. a year.

A CORRESPONDENT writes:—Under the name of the "phonophore" a remarkable telephonic invention is about to be introduced to public notice by Mr. Langdon Davies. The name is given to a contrivance which, while absolutely a non-conductor of continuous electric currents, still allows of the passage or transmission of rapidly-alternating currents such as correspond to sounds in vocal and harmonic telephony. The "phonophore" itself may be regarded as at once a condenser and an induction coil. It consists essentially of two insulated wires laid side by side, twisted together and wound up upon a bobbin, one end of each wire being completely insulated. Regarded as a condenser, its capacity is very feeble indeed. Regarded as an induction coil, it will be seen that neither the primary nor the secondary forms a closed circuit. Yet it transmits telephonic speech perfectly. It follows that Mr. Langdon Davies has solved the problem of telephoning on an open circuit. But the real object of the invention is to enable telephonic messages, including both vocal and harmonic under that name, to be transmitted through the ordinary telegraph-wires without interference with or from the telegraphic messages that are simultaneously passing through the wires. For many months Mr. Langdon Davies has been at work experimenting upon the lines of telegraph-wire running across the county of Kent. He has devised a whole series of new telephonic apparatus in which not only the induction-coils of the transmitters, but also the bobbins of the receivers, are replaced by open-circuit phonophore coils. Apart from its purely technical value, the new instrument presents several points of great scientific interest, and opens up sundry new problems to the mathematical physicist.

A NEW method of reading small angular deflections, as, for example, those of galvanometers, has been devised by Dr. D'Arsonval. It may be briefly described as the inverse of Poggendorff's (subjective) method. Usually the objective of the observing telescope forms at the conjugate focus a diminished image of the object—the scale as reflected in the mirror. Dr. D'Arsonval places the scale—a small one, reduced by photography, giving tenths and twentieths of a millimetre—at this conjugate focus, and obtains a magnified image of it reflected in the mirror, and situated above the objective. This enlarged image, which is enormously displaced for small angular movements of the mirror, is again observed by an eyepiece bearing the usual cross-wires.

THE annual meeting of the Iron and Steel Institute has been arranged to take place in London on the 12th, 13th, and 14th of May next. On the first day of the meeting the President (Dr. Percy, F.R.S.) will deliver an opening address. The Council have decided to present the Bessemer Gold Medal to Mr. Edward Williams, of Middlesbrough, who was for many years connected with the Dowlais Company, and Bolckow, Vaughan, and Company, in recognition of his services to the Institute and to the iron trade generally. The programme embraces a list of fifteen papers, four of which are adjourned from the meeting held in Glasgow last autumn, while eleven are entirely new papers. The subjects dealt with include the manufacture of tin plates (which is still, in spite of recent efforts of the Germans and Americans to secure a portion of the trade, an almost exclusively English industry); American blast-furnace practice; the tenacity of steel wire; the cost of blow-holes in open-hearth steel, by which the strength and reliability of that metal is affected; a neutral lining for metallurgical furnaces; the composition of cast iron; the use of wrought-iron conduit pipes; the manufacture of chrome steel; the endurance of steel rails; the microscopical structure of steel; and certain descriptions of Indian castings.

THE Institution of Mechanical Engineers will hold its next general meeting on Thursday, May 6, at 7.30 p.m., and Friday, May 7, at 3 p.m., at the Institution of Civil Engineers, 25, Great George Street, Westminster. The papers to be read are: "On the Distribution of the Wheel Load in Cycles," by Mr. J. Alfred Griffiths, of Coventry; "On the Raising of the Wrecked Steamship *Peer of the Realm*," by Mr. Thomas W. Wailes, of Cardiff; "On Refrigerating and Ice-Making Machinery and Appliances," by Mr. T. B. Lightfoot, of London; "Notes on the Pumping-Engines at the Lincoln Water-Works," by Mr. Henry Teague, of Lincoln.

MR. CUTHBERT E. PEEK'S Second Report of the Meteorological Observatory he established at Rousdon, Devon, in the end of 1883, has reached us, and it shows in several respects an improvement on the First Report. The weather notes of the months, while retaining their popular character, are now fuller and more precise, and form, so far as can be expected from the records of a single station, a very serviceable account of the weather of the year. A comparison of the weather forecasts of the Meteorological Office with the actual weather experienced at Rousdon continues to form part of the regular work, with the result that for 1885 the reliable forecasts for this part of England were 11 per cent. above that of 1884. Some interesting observations are made regarding sea-fogs and their extension inland, for observing which the Rousdon Observatory is well situated. A useful table is added to the Report in which the months are grouped respectively in order of frequency of sea-fogs, of mean wind velocity, of duration of bright sunshine, of rainfall, and of temperature; and we are glad to see that the mean temperatures of the months are included in the Report. We still, however, desiderate the monthly means for atmospheric pressure and humidity, and certain other details, which, as they are indispensable to such publications, Mr. Peek will, no doubt, include in future issues of his reports.

THOSE interested in the Daily Weather Reports of the Meteorological Office will have noticed with satisfaction the addition, since April 7, of a paragraph headed "Continental Information," which details the general features of the weather over the Continent on the previous day, taken from the data of the Daily Continental Weather Reports. With this greatly extended field of observation, not only is the weather of Europe generally brought more or less vividly before us, but a much clearer explanation is afforded of the more important weather changes occurring in the British Islands than can be given by weather maps covering a more restricted area. It is evident that much assistance would be rendered in framing forecasts of weather if daily telegrams were received from additional Continental stations. The immense importance of this extension will be seen by a reference to the recent anticyclonic areas of high pressure over Russia, often extending westwards through Scandinavia to the north of the British Islands, in connection with the low pressures at the time over southern and south-western Europe, as the immediate cause of the past hard winter (see NATURE, vol. xxxiii. pp. 447-48). Good results may fairly be expected to follow, as the area embraced by the stations increases in extent and in height through the atmosphere.

A CORRESPONDENT points out that the meteorological station at Sonnenblick, near Salzburg, 10,170 feet high, is not the highest in the world, that on Pike's Peak, Colorado, U.S., being 14,134 feet high.

THE various elevated meteorological stations of Europe, with their respective heights in metres, are thus given by Dr. Breitenlohner, the Director of the Observatory at Sonnenblick, near Salzburg, in an article in the last number of the *Mittheilungen* of the Vienna Geographical Society:—Italy—Monte Cimone, Apennines, 2162; Etna, Sicily, 2900. France—Puy-de-Dôme, Auvergne, 1463; Pic de l'Aignal, Cevennes, 1567; Mont Ventoux, Cottian Alps, 1960; Pic du Midi, Central Pyrenees,

2877. Switzerland—Säntis, Appenzell, 2500. Great Britain—Ben Nevis, 1418. Germany—Brocken, Harz, 1141; Wendelstein, South Bavaria, 1860. Austria—Schafberg, near Ischl, 1776; Hoch-Obir, Carinthia, 2047; Sonnenblick, Salzburg, 3103. These heights are taken from the sea-level.

FOR the first time the Government of the Straits Settlements has published in the official *Gazette* a separate meteorological report on the result of observations taken in the three settlements—Singapore, Malacca, and Penang—comprising atmospheric pressure, temperature, wind, rainfall, &c. The statistics, which are edited by Dr. Rowell, embrace the year 1885. Carefully compiled tables of observations and four charts are attached to the report.

AT a recent meeting of the Russian Archæological Society, Prince Putiatin reported his important discovery near the Bologne railway station (half way from St. Petersburg to Moscow) of an image of the constellation of Ursa Major engraved on a grindstone of the Stone period. A similar discovery, as is known, had already been made near Weimar in Germany.

THE sixteenth annual report of the Wellington College Natural Science Society is satisfactory as showing that the society is pursuing its useful work with much success. A considerable number of lectures on various scientific topics were delivered during the session, one of them being by Prof. Flower, and the usual phenological and meteorological reports are added. The value of such societies as these in connection with our public schools is obvious, and it is only to be wished that the list of school natural history associations were a much longer one. At present, we believe, there are only nine in all—Wellington, Winchester, Cheltenham, Marlborough, Clifton, Rugby, Dulwich, Haileybury, and King Edward's, Birmingham. Neither Eton nor Harrow, it will be noticed, is on the list, although both are favourably situated for the purpose.

A CORRESPONDENT at Gorebridge writes to the *Scotsman*:—On Thursday week (April 8), at twenty minutes past twelve, a slight shock of earthquake was felt in this locality. The low rumbling and vibration were felt by your correspondent quite plainly, though at first I did not put it down to its real cause. Afterwards I found that the miners employed in Lord Lothian's Newbattle pits, about a mile to the westward, had been alarmed by loud explosions and vibration of the strata in which they were employed. In East Bryans pit, a mile further to the north-east, the miners had a like experience, being also of the belief that an explosion had occurred in the workings. In the villages of Cowdengrange and Newtongrange the shock was felt most distinctly, houses and furniture appearing to oscillate, and the crockery in some instances falling from the shelves. The phenomenon lasted for about five seconds, travelling from east to west, but appears to have been confined to the low range known as the Roman Camp. About half-past twelve on Sunday morning a shock of earthquake was distinctly felt in Comrie and neighbourhood, as well as in St. Fillans district. Several of the inhabitants state that they were awakened by the peculiar tremor, and that there was a dull heavy sound at the time of the shock, resembling distant thunder. The vibration apparently passed from the north-west towards the south or south-east.

THE last number of Prof. Caporali's *Nuova Scienza*, which continues to attract general attention on the Continent, is of a somewhat iconoclastic character. After dealing with the inherent difficulties and contradictions of Prof. Sergi's materialistic doctrines, it proceeds to attack with its customary vigour and learning the modern school of metaphysicians, who study the mental and outward phenomena of nature from the subjective instead of the objective stand-point. Kant himself is not spared, and it is argued that, were his views accepted regarding the negative character of the concept of space, all progress in positive science would be arrested. No induction could be made from the known to the unknown, because nothing would ever be known with certainty, not even the very ground on which we stand. The followers of these idealistic theories are compared to mariners navigating a shoreless ocean, and ingulfed at last in a sea of phenomenalism and pure scepticism. Crude materialism and idealism being thus both set aside, Prof. Caporali returns to his own theory of the universe, which aims at a complete reconciliation of the psychic and mechanical views of material and biological evolution from the atom to the last outcome in the human intellect.

THE French Minister of Commerce has decided, subject to the approval of scientific men and specialists, to erect, either at the entrance, or at some other part of the Paris Exhibition, the gigantic metallic tower invented by M. Eiffel, the mechanical engineer. It will be 300 metres in height, and entirely constructed of iron. It will rest on five pillars, forming four immense arcades, lofty enough to exceed in height the towers of Notre Dame. On the summit of the tower will be erected an electric light-house, and a terrace to which visitors will be admitted. The tower is expected not only to be an extraordinary source of attraction to the building, but to render important services to science. It is suggested that meteorological and astronomical observations will be made at the summit under entirely novel conditions. An electric signal, placed on the summit of the tower, may be seen in clear weather at Dijon—a fact which will give the erection great importance in connection with military signalling and national defence.

AN interesting account of the latest information concerning the former bed of the Amu-Daria River was recently given by Baron Kaulbars before the Russian Geographical Society. He ascribes the alteration of the course of the river between Kilik and the Khiva oasis principally to the terrace-like character of the locality along which it runs; and, secondly, to the softness of the strata of the bed at the point where the river leaves the mountains. The strata are washed off, and their remains precipitated on a slightly inclined slope of the Chardjui oasis, producing periodical inundations. Consequently, reeds are growing, and lakes are formed along the bed of the river as the course of the water filtering through the reeds becomes slower and slower. Finally, the lakes, increasing in size and number, reach the edge of the terrace, overflow it, and open a new course for the river along another slope.

WITH reference to a communication which recently appeared in NATURE respecting a Fishery Board for England, and the remark that there is no Fishery Board in Norway, a correspondent writes that, though there is no Fishery Board in Norway, there is a General Inspector of Fisheries, Prof. A. Landmark, and that the Government have just appointed a Board consisting of three members, who shall be practical men, knowing the best markets, &c., which would be of benefit to the Norwegian fisheries. We ought to add that the reports and suggestions recently issued by the Norwegian Inspector of Fisheries contain many valuable hints respecting the salmon- and trout-fishing in Norway, and the Inspector seems fully alive to the necessity of enacting as stringent fishery laws for Norway as those in force in this country.

IN the year 1882–83 the Norwegian Inspector of Fisheries imported at the public expense a parcel of ova of the American trout (*Salmo fontinalis*), with a view to introduce this fish into Norwegian waters, and the result has been so satisfactory that last autumn one of the hatching establishments near Christiania had some 30,000 young fish to offer for sale, which were then about two and a half years old. The result appears to have been welcomed with great satisfaction in Norway, as it proves that this fish is capable of increasing in almost stagnant waters, where the Norwegian trout cannot exist, though its size is smaller. As an example of the success of this experiment it may be mentioned that the Norwegian Inspector of Fisheries, Prof. A. Landmark of Christiania, offers these ova at ten shillings per thousand.

THE additions to the Zoological Society's Gardens during the past week include a Garnett's Galago (*Galago garnetti*) from West Africa, presented by the Rev. W. C. Porter; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. James B. Bevington; a Common Badger (*Meles taxus*), British, presented by Mr. E. Gully; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. Bateson-de-Yarburgh; six Barbary Turtle Doves (*Turtur risorius*) from Africa, presented by Mr. Richard Seyd, F.Z.S.; a Robben Island Snake (*Coronella phocarum*) from Robben Island, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Pale-headed Tree Boa (*Epicrates angulifer*) from Cuba, presented by Miss M. Hunt; an Ogilby's Rat Kangaroo (*Hypsiprymnus ogilbyi*), a Roseate Cockatoo (*Cacatua moluccensis*) from Australia, three Poë Honey-eaters (*Prosthemadera novæ-zealandiæ*), a Huia Bird (*Heterolocha gouldi*), five —— Gannets (*Sula* ——) from New Zealand, deposited; two Collared Fruit Bats (*Cynonycteris collaris*), born in the Gardens.

GEOGRAPHICAL NOTES

THE last number of the *China Review* contains the first part of an article by Mr. G. Taylor on that interesting and little-known subject, the aborigines of Formosa. The writer has lived in the extreme south of the island, in daily communication with the people there for four years, and has therefore more experience of the southern type than all previous writers put together. He divides the Formosans south of Takow—that is, the southern peninsula—into four parts: the Paiwans, inhabiting the extreme south; the Pepohuans, or half-castes, of the plains; the Tipuns, inhabiting the great plain inland from Pilam; and the Ameirs, who have scattered themselves in small villages along the east coast down to South Cape. Of these, he can speak of the Paiwans from intimate personal observation; the Ameirs he is also acquainted with; but in the case of the others he has gathered his information from straggling members who have been found domiciled among the Paiwans. The present instalment is devoted wholly to the latter, *Paiwan* being the generic name of all the savage tribes on the south coast, and on the west up to Tang-Kang. These, at least, show no traces of the Negrito mixture which is supposed to exist among certain Formosan tribes. They are of a bright copper complexion, with black, straight hair, of a coarse texture. Mr. Taylor describes their physical features, their traditions of their origin, their arts (which are disappearing through contact with the Chinese), their superstitions and customs. They have a dim belief in the transmigration of souls, probably derived from Buddhist sources, and think that some souls are, as a mild punishment for minor misdeeds, condemned to pass into certain animals, where they remain for a time. The Subongs, a northern tribe of the Paiwans, are still almost absolutely independent, and still preserve the practice of head-hunting. They have known and wrought iron as far back as their traditions extend; they wear a ring in the lobe of the ear inserted in a hole formed by gradual expansion, and these ear-rings are the true mark of aboriginal descent, half-castes and Chinese not being allowed to wear them. One tribe of Paiwans, the Koaluts, has the custom of killing off infants when the tribe increases beyond a certain number, the saying being that whenever their tribe increases beyond the traditional limit they are certain to be visited by a pestilence. The paper is very interesting, and the whole promises to be a work of much ethnological value.

TELEGRAMS from Cairo and Aden announce the massacre by the Emir of Harrar, in the Somali country, of the members of an Expedition sent out by the Geographical Society of Milan. The Expedition was under the charge of Count Porro, and, besides the leader, the other victims were the Count Montiglio, Prof. Sicata, Dr. Gethardi, Signori Romagnoli, Janin, Bianchi, and two servants. They were set upon by the Emir with 200 soldiers between Geldessa and Arton.

ACCORDING to information received in Paris, M. Barral and his wife, who had set out from Obock to explore a great part of Abyssinia and to establish commercial relations in the country, were murdered by the Danakils on the frontiers of Shoa.

THE *Izvestia* of the East Siberian branch of the Russian Geographical Society are appearing now in a new shape, similar to that of the *Izvestia* of the St. Petersburg Geographical Society. The last issued fascicule contains a short account of the geological excursions undertaken by the Society during the years 1883 and 1884. M. Dubroff continues the report of his journey to Mongolia, in which he gives much valuable topographical information concerning the valleys of the rivers Baikoy, Eder, Delgir-Moria, and Selenga, as also some ethnographical notes. M. Cherski contributes a paper containing the geological observation he has made during a journey from Irkutsk to the river Nijnia Tunguska. A good deal of attention was paid by the author to the geological features of the valley of the Middle Lena (from Kachug to Kirensk), which had been visited formerly by many explorers (Zlobin, Erman, Stchukin, Meglicki, Middendorff, Krapotkin, and Chekanefski), but never made a subject of special investigation. M. Cherski found there in the red sandstone of the valley some valuable exterior casts of shells similar to those of *Orthis*, but unfortunately the specimens were subsequently spoiled on their way to St. Petersburg, and therefore the question concerning the origin of the red sandstone still remains open. Finally he describes the Mammalia which now inhabit the valley of Nijnia Tunguska, as also those which inhabited it during the Palæolithic period, such as *Bos priscus*, *Bos primigenius*, *Rhinoceros tichorrhinus*, *Elephas primigenius*, *Cervus canadensis*, and *Castor fiber*, the last three having only disappeared in recent time.

DR. KONRAD KELLER, of the Zürich University, is about to start on a scientific exploring expedition to Madagascar. The Swiss Ministers of Agriculture, Commerce, and Internal Affairs, the Mercantile Society of Zürich, and the East Swiss Commercial Geographical Society will jointly bear the cost of the expedition.

OUR ASTRONOMICAL COLUMN

THE PARALLAX OF ψ^5 AURIGÆ.—Herr W. Schur, of Strassbourg, has published in the *Astronomische Nachrichten*, No. 2723, a determination of the parallax of this double-star, deduced from a series of measures of position-angles and distances of the components made by him with the 6-inch refractor of the Strassbourg Observatory, on thirty evenings between January 14, 1883, and January 29, 1885. Transforming the observed position-angles and distances into $\Delta\alpha \cos \delta$ and $\Delta\delta$, and attempting, first, to determine corrections to the assumed proper motions of the brighter star (taken from Auwer's Fundamental-Catalog.), Herr Schur finds—

Correction to assumed proper motion in $\Delta\alpha \cos \delta = +0''{\cdot}075 \pm 0''{\cdot}027$, $\pi = +0''{\cdot}161 \pm 0''{\cdot}036$.

Correction to assumed proper motion in $\Delta\delta = +0''{\cdot}013 \pm 0''{\cdot}021$, $\pi = -0''{\cdot}011 \pm 0''{\cdot}096$.

Combining the two values of the parallax resulting from the differences of R.A. and declination respectively, there results $\pi = +0''{\cdot}140 \pm 0''{\cdot}034$. An examination of the measures of this double-star, made from Herschel's time on, shows that there is no perceptible orbital motion in the system, but also shows that this comparatively large correction to the assumed proper motion in $\Delta\alpha \cos \delta$ is inadmissible. Putting, therefore, these corrections to the assumed proper motions = 0 in his equations, the circumstances being unfavourable for their determination, Herr Schur finds—

From differences of R.A., $\pi = +0''{\cdot}126 \pm 0''{\cdot}036$
,, Decl., $\pi = -0''{\cdot}009 \pm 0''{\cdot}094$

and, finally, $\pi = +0''{\cdot}111 \pm 0''{\cdot}034$. It is to be remarked that this value refers to the fainter star of the pair (mag. 9·0, that of the other component being 5·3 according to Struve's estimate), in the observations the place of this star having been referred to that of the brighter one. Herr Schur thinks he is justified in asserting that the parallax of this star is at least $0''{\cdot}1$,—a remarkable result considering the fixity of the object.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MAY 2-8

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 2

Sun rises, 4h. 32m.; souths, 11h. 56m. 50·4s.; sets, 19h. 22m.; decl. on meridian, 15° 26′ N.: Sidereal Time at Sunset, 10h. 4m.

Moon (New on May 4) rises, 4h. 10m.; souths, 10h. 42m.; sets, 17h. 25m.; decl. on meridian, 5° 29′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 0	10 23	16 46	3 50 N.
Venus	3 13	9 5	14 57	2 18 S.
Mars	12 40	19 57	2 55*	10 39 N.
Jupiter	14 49	21 7	3 25*	2 43 N.
Saturn	7 26	15 38	23 50	22 51 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
6	111 Tauri	5½	20 12	21 3	114 324
6	117 Tauri	6	21 42	22 21	88 342

Saturn, May 2.—Outer major axis of outer ring = 39″·1; outer minor axis of outer ring = 17″·4; southern surface visible.

May	h.	
2	1	Mercury in conjunction with and 0° 6′ south of the Moon.
7	1	Mercury at greatest elongation from the Sun, 26° west.

Positions of the Comet Barnard (for Berlin Midnight)

May	R.A. h. m. s.	Decl. ° ′	Log. Δ	Brightness
2	1 38 8	40 28 N.	9·956	118
4	1 39 14	40 6	9·924	136
6	1 41 34	39 23	9·889	155

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Monocerotis	7 25·4	9 32 S.	May 6,	0 0	*M*
R Crateris	10 55·0	17 43 S.	,, 3,	0 0	*M*
δ Libræ	14 54·9	8 4 S.	,, 2,	3 0	*m*
U Coronæ	15 13·6	32 4 N.	,, 6,	23 35	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 5,	3 4	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	May 5,	2 20	*m*
			,, 8,	0 0	*M*
U Sagittarii	18 25·2	19 12 S.	,, 2,	21 40	*m*
			,, 5,	21 35	*M*
β Lyræ	18 45·9	33 14 N.	,, 3,	2 25	*m*
η Aquilæ	19 46·7	0 7 N.	,, 7,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

There are no showers of great importance visible during this week. Meteors from the following radiants have been observed in previous years:—From Crater, R.A. 170°, Decl. 10° S.; near α Ursæ Majoris, R.A. 170°, Decl. 62° N.; from Virgo, R.A. 202°, Decl. 9° N.; from Aquila, R.A. 290°, Decl. 10° N.; and one with radiant at R.A. 234°, Decl. 46° N.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
S Coronæ	15 16 45	31 46·7 N.	III.
τ^4 Serpentis	15 31 11	15 28·7 N.	III.
R Serpentis	15 45 26	15 28·8 N.	III.
367 Birmingham	15 59 41	47 33·1 N.	III.
47 Serpentis	16 2 58	8 50·3 N.	III.
371 Birmingham	16 3 7	8 55·1 N.	III.
δ Ophiuchi	16 8 22	3 23·9 S.	III.
V Ophiuchi	16 20 24	12 9·5 S.	IV.
α Scorpii	16 22 25	26 10·6 S.	III.
g Herculis	16 24 53	42 7·9 N.	III.
α Herculis	17 9 26	14 20·2 N.	III.

ON THE FORCES CONCERNED IN PRODUCING THE SOLAR DIURNAL INEQUALITIES OF TERRESTRIAL MAGNETISM[1]

IN an article on terrestrial magnetism in the present edition of the "Encyclopædia Britannica," I have endeavoured to show two things:—

(1) That of all the various hypotheses which have been started with the view of explaining the solar diurnal inequalities of terrestrial magnetism, the most probable is that which considers these inequalities to be caused by electric currents in the upper regions of the earth's atmosphere.

(2) That in the neighbourhood of the North Magnetic Pole (judging from observations discussed by Sabine) such currents have in all probability horizontal components flowing in from all sides towards that pole, so that on one side of the pole this component will have a direction the reverse to that which it has on the opposite side of the pole.

Dr. Schuster (see Report of Magnetical Committee of British Association) has deduced from this the legitimate inference that here we must have a vertical current or component of currents, inasmuch as without this we cannot imagine a series of strictly horizontal currents flowing in from the circumference to the centre like the spokes of a wheel.

I think it is desirable that this method of discussion should be extended to the phenomena round the magnetic equator. This magnetic equator may be regarded as approximately coincident with the terrestrial equator. It is the line all along which the freely suspended needle points horizontally, just as the magnetic pole is the place at which the freely suspended needle points vertically downwards.

Now a little to the north of the magnetic equator we have, broadly speaking, the following phenomena:—

(1) When the sun is north of the line, the influence of the sun upon the declination-needle (as represented by that oscillation which culminates an hour or two after noon) tends to drive the North Pole to the west. But when the sun is south of the line this action becomes reversed, and drives the North Pole eastwards.

(2) Whether the sun is north or south of the line, its action upon the bifilar needle (as represented by that oscillation which culminates about noon) tends to increase the horizontal force.

Now let us go a little to the south of the magnetic equator, and we find the following behaviour:—

(3) When the sun is south of the line, the influence upon the declination-needle represented as above tends to drive the North Pole to the east. But when the sun is north of the line this action becomes reversed, and the North Pole is driven westwards.

(4) Whether the sun is north or south of the line, its action upon the bifilar needle, represented as above, shows that it tends to increase the horizontal force.

It is, indeed, well known that there is a north-hemisphere and a south-hemisphere action of the sun upon the declination-needle, the one being the reverse of the other, and the southern limit of the first action being the northern limit of the second. And furthermore this boundary line oscillates backwards and forwards, so that, when the sun is in the north, a station near the equator, but north of it, exhibits a more distinctively northern character of oscillation, while, when the sun is in the south, it will exhibit a more or less southern character in its oscillation.

If we now venture to ascribe the actions represented in (1), (2), (3), and (4) to currents in the upper atmospheric regions, we shall have—

(1) when the sun is north, caused by a positive current going from south to north;

(2) caused by a positive current going from west to east;

(3) when the sun is south, caused by a positive current going from north to south;

(4) caused by a positive current going from west to east.

The resultant of (1) and (2) would be a horizontal positive current going in a direction not far from south-west, and the resultant of (3) and (4) a similar current going in a direction not far from north-west. The analogy in direction as well as oscillation to the two systems of anti-trades is at once apparent, and it will be strengthened if we reflect that, in the magnetical as well as the meteorological system, we must have a vertical current at the equator. This current might probably be repre-

[1] Being the substance of a Paper recently read before the Literary and Philosophical Society of Manchester, by Prof. Balfour Stewart, F.R.S.

sented by one carrying positive electricity down or negative electricity up, whereas that at the North Magnetic Pole might be one carrying positive electricity up or negative electricity down. We say *probably*, because it is exceedingly difficult to imagine that either of these vertical currents goes through the lower regions of the atmosphere into the earth, and it is likewise very difficult to imagine that the system of currents is an open one. They must, therefore, somehow close themselves in the upper atmospheric regions, and we may thus perhaps imagine that, while we have an ascending current at the North Magnetic Pole, we have a series of descending positive currents at the equator.

Or, if we prefer to render the analogy between the meteorological and magnetical systems more verbally complete, we should say ascending negative currents at the equator and descending negative currents at the pole.

These vertical currents being supposed to be confined to the upper regions of the atmosphere, we might imagine that they ought to render themselves visible at the magnetic pole, where they are most concentrated. If so, they would appear as a luminous vertical curtain or fringe suspended in mid-air. This at once suggests to us that the well-known form and nearly continuous appearance of the aurora in these regions may be due to this cause, and may represent to us the vertical component of those currents which we have here supposed to be the causes of the solar diurnal magnetic variations. It must not, however, be supposed that in making this suggestion we imply that phenomena of an auroral nature are not likewise connected with magnetic disturbances.

It is to be remarked in conclusion that a system of atmospheric currents will act inductively on the terrestrial magnetic system, so that the final effect on the needle will be the conjoint effect of the currents above and of the magnetic change below. In the case of the declination it is our inability to express the force that acts near the equator or near the magnetic pole in terms of any conceivable general change in the magnetic system that induces us to look to atmospheric currents as affording us a simpler mode of expressing observed facts. This, however, does not hold for the horizontal force near the equator. A set of currents moving east in both hemispheres will produce by induction a definite and well-understood effect upon the terrestrial magnetic system. We do not, therefore, know how far the change produced by the sun upon this element is due to a cause above the needle or how much to magnetic change below; and in this respect the conclusions we have deduced may require modification.

ON THE DIURNAL PERIOD OF TERRESTRIAL MAGNETISM [1]

THE explanation of the daily variation of the magnetic forces observed on the surface of the earth will, in all probability, lead to the explanation of the mysterious connection between solar phenomena and terrestrial magnetism. For the increase in amplitude of the diurnal variation of the horizontal components of magnetic force forms one of the most striking effects accompanying the increase in sunspot activity. The daily variation, then, seems a most important symptom of solar in-influence, and its investigation becomes a matter of great interest.

In the remarks which I wrote out for the Report of the Committee appointed by the British Association for the purpose of considering the best means of comparing and reducing magnetic observations, I pointed out the importance of adopting a suggestion, made already by Gauss, to apply the analysis of surface harmonics to the diurnal oscillations. It is well known that such an analysis would allow us to decide the question whether the immediate cause of the disturbance was inside or outside the surface of the earth; nor can there be two opinions as to the importance of definitely settling that question. At the time I wrote out my suggestions, however, it seemed to me that, as the causes of the disturbance had their seat in all probability close to the surface, whether outside or inside, that we should require a large number of terms in the expansion before we could arrive at a definite result.

In this I was mistaken, and it is one of the principal objects of this paper to show that the periodic variations adapt themselves with great facility to the analysis, and that even with the very limited quantity of material at our disposal we shall be able to arrive at most important results; results which within a short time might be made absolutely certain if additional observations at a few well-selected stations are taken. My results, as far as they go, point definitely to the region *outside the surface of the earth* as the locality of the periodic cause of the variation. It is easy to see that, if electric currents parallel to the earth's surface produce any disturbance, we can readily find out whether these currents are outside or inside the earth. As we pass through any current-sheet, the normal magnetic force remains continuous, but that tangential component which is at right angles to the current suffers a discontinuity depending on the intensity of the current. For a spherical current-sheet these components will always be of opposite sign. If we then find the distribution of magnetic potential on the surface of the earth from the horizontal components only, we should get by calculation a vertical component of different sign according as the cause is inside or outside. A comparison with the observed values will at once decide the question. A more careful analysis is necessary, if the causes are partly outside and partly inside, and we wish to determine their relative importance.

I believe that few practical magneticians at the present day read Gauss's memoir "On the General Theory of Terrestrial Magnetism," and the loss which cosmical physics has suffered in consequence is, as far as our generation is concerned, quite irretrievable. The memoir is a model of scientific reasoning, and full of suggestions which are as valuable now as they were fifty years ago. The investigations of Gauss are founded on the assumption of a magnetic potential on the surface of the earth, but that assumption requires justification in the case of magnetic disturbances. There will be no potential if there is a discharge of electricity through the earth's surface, and a variation of electric charge would be equivalent to a current. Calculation shows that electrostatic experiments on the surface of the earth would have shown before now if there was a sufficiently rapid change in electric potential to cause a disturbance of the magnetic needle. As regards an actual discharge, it is difficult to form an estimate, and we have therefore to fall back on magnetical observations, and see whether or not they seem to show that the line-integral of magnetic force taken round a closed curve vanishes. The calculations of the author, made on the assumption that it does vanish, seem to show a general agreement with fact; but some observations of Sabine, taken near the magnetic pole, would, if confirmed, point to a discharge in the Arctic regions.

The determinations of the diurnal variation of the magnetic variations show such a remarkable regularity everywhere except in the Arctic regions, and especially in latitudes between 20° and 60°, that we may as a first approximation express the westerly force (measured as change in declination) as the product of two quantities, one changing with local time, the other with latitude only. This assumption leads to the conclusion that the northerly component of force ought to be a maximum or minimum when the declination-needle passes through its mean position. This is very nearly true at Greenwich, Bombay, Lisbon, and Hobart. The agreement is not quite so good at the Cape of Good Hope and in St. Helena, but the observations at these places show some marked anomalies. It is found by observation that the variation in declination increases with the latitude, and we may as a first approximation put it proportional to the sine of the latitude. Writing γ for the westerly, χ for the northerly component of force, u for the co-latitude, λ for the longitude reckoned towards the east, and t for the local time, we may put

$$\gamma = \cos u \cos (t + \lambda).$$

It follows from this, on the assumption of the existence of a potential, that

$$\chi = \cos 2u \sin (t + \lambda).$$

The important point here is the factor $\cos 2u$, which changes sign at a latitude of 45°. If our equation is approximately right, the northerly force ought to be a maximum in the morning, a minimum in the afternoon in the equatorial regions where $\cos 2u$ is negative, while in latitudes above 45° the minimum ought to take place in the morning. This is exactly what happens, with the exception that the change seems to take place in latitudes smaller than 45°. At Bombay the *maximum* of horizontal force takes place at 11 o'clock a.m. At Greenwich the *minimum* takes place a little after that time.

At Lisbon (u = 51°) the phase agrees in summer with Greenwich, and in winter with Bombay, the Greenwich type pre-

[1] Abstract of a Paper read before the Manchester Literary and Philosophical Society, by Arthur Schuster, F.R.S.

ponderating; we may conclude that the latitude at which the change of phase takes place shifts with the season, and that its average position is not far south of Lisbon.

The good agreement of our formulæ with the observed facts encouraged me to deduce the vertical component of force. Measured downwards it should be

$$\sin 2u \sin (t + \lambda)$$

if the cause of the disturbance is outside the earth, but

$$- \tfrac{3}{2} \sin 2u \sin (t + \lambda)$$

if the cause of the disturbance is inside the earth.

Both expressions have their maxima and minima coincident with those for the northerly components of horizontal force, a fact which finds its confirmation in actual observation. They also show the phase of the vertical force to be the same for each hemisphere and not to change as with the horizontal force. But there is an important distinction: while the vertical force has its maxima and minima coincident with the maxima and minima of horizontal force at latitudes greater than 45°, in the equatorial regions the maximum of horizontal force ought to be coincident with the minimum of vertical force, and *vice versâ*, if the cause is outside the earth's surface; the opposite should be the case if the cause is inside.

At Greenwich the maximum of northerly force takes place at 7 p.m., the minimum at noon; the maximum of vertical force takes place at 7 p.m., the minimum at 11 a.m.

At Bombay the maximum of northerly force takes place at 11 a.m., the minimum at 9 p.m.; there is a very decided minimum of vertical force at 11 a.m; but there is no pronounced maximum; two minor maxima occur, one at 6 a.m. and the other at midnight.

As far as these results go they give an emphatic answer in favour of the supposition that a great part at any rate of the disturbing currents lie outside the earth's surface, a view which Prof. Balfour Stewart has often supported in the last few years. The results seem to me very encouraging, and I hope soon to be able to make use of more material and to obtain more accurate expressions for the various forces concerned.

If we make use of the actual observations of Bombay and Greenwich, we may calculate for each hour the intensity and direction of the currents which would produce the disturbance. This has been done, and the results have been collected in a table.

It is very remarkable how very nearly at the same local hours the currents flow north and south at Bombay and at Greenwich, namely, at 4 in the afternoon and between 7 and 8 in the morning. It is curious, moreover, to find how very quickly the current turns through the meridian: at Bombay, at 3 o'clock, it flows at an angle of 15° from the east, and at 5 already it flows due west, and remains almost unaltered in direction till 5 o'clock in the morning. At Greenwich the currents turn much less sharply, but they always flow east when the currents at Bombay flow west. The system of currents indicated is that approximately shown by the equations given in the paper, the phase, however, being different. Along the meridian on which the local time is 4, the currents flow from the equator towards the north; they turn round in our latitudes towards east and west, join on either side again to go south, where the local time is 7.30 in the morning, and come back along the equator.

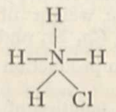
The strength of the currents is approximately of the same order of magnitude as the currents we are accustomed to send through our vacuum-tubes, but as the thickness of layer through which they are distributed must be very large compared to that on which we experiment, the current-intensity at each place is very small, far too small to cause luminosity. The currents, on the whole, are weaker at Greenwich than at Bombay, but, while they almost vanish at one time at Bombay, making the ratio of the strongest to the weakest current equal to 73, that ratio is only $3\frac{1}{2}$ at Greenwich. The minimum at Greenwich in the early morning is as pronounced as the afternoon minimum, but much less so at Bombay.

On the whole, the numbers, both as regards direction and intensity, show such a remarkable regularity that there is good hope of obtaining a good mathematical representation of their distribution.

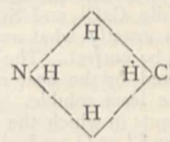
CHEMICAL AFFINITY AND SOLUTION

IN 1878 I read a paper to the Royal Society of Edinburgh, in which I stated my opinion, based on the results of a considerable number of experiments, that chemical combination solution and suspension of solids, such as clay, in water differ in degree only, and are manifestations of the same force; and that there seems to be a regular gradation of chemical attraction from that exhibited in the suspension of clay in water up to that exhibited in the attraction of sulphuric acid for water, which we call chemical affinity. Further, I stated that the attraction of chemical affinity is not, in all cases, at any rate, exhausted when a definite compound is formed, but has sufficient power left to form solution or suspension compounds. In 1881 I read another paper on chemical affinity and atomicity, in which I went a step further, and endeavoured to show that the theory of valency as usually held was incorrect in assuming chemical affinity to act in units or bonds, and insufficient to account for the various phenomena of varying atomicity, or valency, molecular compounds, crystallisation, solution, alloys, &c., and that all these varied phenomena were simply due to the chemical affinity of the elementary atoms, and that the difficulties disappeared if we got rid of the idea of the indivisible units of chemical affinity, and considered it as a whole acting all round, and spreading out, so to speak.

As an illustration of my views, I considered the compounds, HCl, NH_3, and NH_4Cl. In HCl we have two monovalent elements combined, and their chemical affinities completely neutralised or satisfied. In NH_3 we have N considered as a trivalent element satisfied with three monovalent elements. Now these two completed, neutralised or satisfied compounds combine with one another to form the third compound, NH_4Cl. How is this? The usual answer is that N sometimes acts as a pentavalent atom, and in this particular case does so, and the compound is represented graphically thus:



I pointed out that this explanation was most unreasonable, and to me, indeed, incredible, because it supposes that N, which has usually such a weak affinity for Cl, can nevertheless decompose the HCl into its constituent atoms, and fix the atom of Cl to itself. While on the other hand the Cl leaves the H, for which usually its affinity is so great, and unites itself to the N, for which usually its affinity is so small, and this while the atoms are in such close proximity, as they must be in a molecule, and with so many hydrogen atoms allied with it. My explanation was simply this. The affinity of the Cl acts on all the four atoms of H, and the affinity of the N does the same; and thus the whole molecule is held together, and may be represented thus:



I did not, however, exclude the idea that the Cl and N react on one another to some extent, but the *main* cause of the combination is as stated above.

Since these papers were read chemists seem to me to be coming more and more to my views in this matter. Thus Pattison Muir in his "Chemical Principles," says: "It seems to me that a most important step will be made if the bond theory of valency is generally abandoned; with it will go all those quasi-dynamical expressions, the offspring of loose and slipshod ways of thinking which have gathered round that strange anomaly, a unit of affinity employed as a variable standard for measuring nothing." Further, he says, in reference to the behaviour of acetic acid vapour when exposed to a high temperature: "If this is so, we evidently have a series of substances beginning with solution of salts or gases in water and proceeding through crystallisation and acetic acid vapour at low temperature, which connects mechanical mixtures on the one hand with stable gaseous compounds on the other."

Again, Professor Armstrong, in his address to the Chemical Section of the British Association at Aberdeen last year, says that in his view molecular compounds are held together by what, for want of a better name, he calls surplus, or residual affinity. In view of these and many other similar expressions of opinion, all tending in the same direction, I may perhaps be excused for again bringing forward the subject.

In the present paper, however, I shall confine myself mainly to the subject of solution, for two reasons. First, because it seems to me that if we can satisfactorily account for this part of the subject, the remainder will be easily and naturally explained; and, second, because from a study of Thomsen's researches on thermo-chemistry, as given in Muir and Wilson's recent work on that subject, I have obtained data which seem to me almost to demonstrate the truth of my views on the subject of solution.

In my paper of 1881 I explained solution to be due to the affinities of the constituent elements of the body dissolved for the constituent elements of the solvent. Thus NaCl dissolves in water because of the affinity of the Na of the salt for the O of the water, and of the Cl of the salt for the H of the water. These affinities not being strong enough to cause double decomposition, an indefinite compound is formed having the properties of what we call a solution. If this explanation be correct, we should expect that the relative strengths of the affinities of Na, O, Cl, and H should have an effect on solution, and that if we substituted another metal for Na whose affinity for Cl and O was greater or less, we should have a corresponding change in the solubility of the salt. If, for instance, this other metal had greater affinity for Cl and less for O, we should expect the salt to be less soluble, because the Cl would be held more firmly, and could not act so energetically on the H of the water, while the action of the metal on the O of the water would also be less. Now it may be admitted generally that the heat evolved in similar chemical operations is a measure of the chemical affinities of the elements concerned, or at least of their relative affinities. With these explanations, let us consider some of Thomsen's results. He finds as the result of numerous experiments that as the atomic weight of the metal increases in similar compounds of Mg, Ca, Sr, and Ba,

(1) Heat evolved in production of MCl_2 *increases*
(2) ,, ,, MO *decreases*
(3) ,, solution of MCl_2 ,,
(4) Solubility of MCl_2 in water ... ... ,,

These results apply to the alkali metals also.

To make these considerations plain, consider the following table:—

Metal	Heat of formation of chloride	Heat of formation of oxide	Heat of solution of chloride
Mg	151,010	146,000	35,920
Ca	169,820	130,930	17,410
Sr	184,550	128,440	11,140
Ba	194,740	124,240	2,070

Now the order of solubility of these chlorides is exactly as these results would lead us to expect, $MgCl_2$ being most soluble, and $BaCl_2$ least so, while $CaCl_2$ and $SrCl_2$ are intermediate; and the whole result is exactly what we should expect if my explanation of solution be correct. The chloride of the metal whose affinity (as measured by the heat evolved) is greatest for Cl, and least for O is the least soluble. Again, let us take the following series of elements in which the heats of combination with equivalents of either Cl or O gradually decrease (excepting Na for O), but that of Cl much faster than that of O, so that after passing Al the heat of combination of one equivalent of O is greater than that of Cl, and consider the action of the chlorides towards water:

NaCl	Soluble.
$MgCl_2$	,, but decomposed on evaporation.
$AlCl_3$	,, forms crystals with water, and decomposed on further heating.
$SiCl_4$, PCl_3, PCl_5	In contact with water, more or less quickly decomposed.
SCl, SCl_4	Instantly decomposed in contact with water.
Cl gas	Dissolves in water, which it slowly decomposes on exposure to sunlight. Also at low temperature combines with water, forming compound $Cl5H_2O$. The behaviour of this gas is interesting, becouse it brings gases under the same principle of solution.
KCl	Soluble.

We have thus a regular gradation of change, from simple solution through double decomposition to solution again, according as the affinities of the elements for Cl and O vary. Thus solution appears as a periodic function of the elements.

Let us take another case, where the affinities of the elements for Cl and O again regularly decrease, but where the affinity for the O diminishes faster than that of the Cl, and note the result. The following group of elements represents this case:

NaCl	Soluble.
CuCl	Insoluble, or nearly so.
$CuCl_2$	Soluble.
AgCl	Insoluble.
AuCl	,,
$AuCl_3$	Soluble.

Now it will be observed that Cu, Ag, and Au have a small affinity for O compared to what they have for Cl; especially is this the case with Ag, and when these elements combine with only one atom of Cl, the chloride is insoluble; the affinity of the single atom of Cl for the H of the water, combined with the small affinity of the metal for the O of the water, is too weak to produce solution; but as soon as one or more atoms of chlorine are taken up, the compound becomes soluble through the increased affinity acting on the water.

All this is quite consistent with the view of solution I have proposed. In truth, this view is the most simple and natural explanation of the facts. There are not sufficient data to be obtained to trace these actions through all the various groups and series of elements, but there are numerous indications that they are regular recurring phenomena. I need only mention the analogous behaviour towards water of the chlorides of P, As, Sb, Bi and S, Se and Te.

I have chosen the chlorides to illustrate the principles of solution because of the simplicity of their composition and action, and also because the data are more complete for them than for other salts, but the same principle can be traced through all.

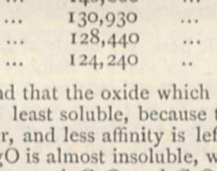
Let us consider, however, for a moment the solution of the oxides. In this case, as the metal is already combined with O, it is not likely to have so much effect on the O of the water. We see, however, the same action taking place. Thus take the following group and their heats of combination and solution:

Metal	Heat of formation of oxide	Heat of solution of oxide
Mg	146,000	2,960
Ca	130,930	18,330
Sr	128,440	29,340
Ba	124,240	34,520

Now again we find that the oxide which has the greatest heat of formation is the least soluble, because the elements are held more firmly together, and less affinity is left to act on the water elements. Thus MgO is almost insoluble, while BaO is the most soluble of the group, and CaO and SrO intermediate. This order is the inverse of that of the chlorides, as the heat of formation is also inverse.

Many examples of the close relationship between the heats of formation and the heats of solution might be given. For example, if we neutralise the hydrates of the above oxides with a solution of HCl, we find the heat evolved approximately the same in all cases, being about 27,600 units. At first sight this appears very curious, seeing their affinities (as measured by heat evolved), for Cl and O vary so much and inversely; but the explanation is obvious enough. The heats of solution of the various compounds decomposed and formed exactly compensate for the variations in the heats of combination; what is lost in one way is gained in another.

Closely connected with solution is the subject of crystallisation. This also is most satisfactorily explained, if the principle I contend for be admitted, and regular structure necessarily follows. For instance, in such a compound as $BaCl_2\,6H_2O$, the atoms of the molecule must be arranged somewhat after the following fashion:



There are many other points connected with this subject, but as the data I can obtain are fragmentary, I shall content myself at present with indicating the direction of my inquiries.

(1) The affinities, measured as before, of the series Na, Mg,

Al, Si, P and S, for Cl, regularly diminish if we take the amount for one atom of Cl in each case; but if we take the actual maximum amount of Cl with which each element in the series combines, a very different result comes out, because while Na combines with one atom of Cl, Mg combines with two, and Al with three, and so on. This leads us to make a distinction between the intensity and quantity of chemical affinity, so that while the *intensity* of affinity in this case regularly diminishes, the *quantity* rises to a maximum in Al, and then diminishes towards S. There is thus a spreading out of affinity which lowers its intensity, and in this there seems to me a gradual approach to solution. I have traced the same phenomena in some oxides, and it is interesting to note that the atomic weight of Al, whose affinities for Cl and O are nearly equal, is almost exactly midway between the atomic weights of O and Cl. It is, so to speak, the point where the two curves of affinity cross one another. On the one side the affinity for Cl relatively to that for O increases, and on the other side decreases. This may throw some light on the peculiar properties of Al. Fe, which is in many respects analogous to Al, and has an atomic weight about twice that of Al, and almost midway between Cl and Br, shows somewhat similar relations towards Cl and O. It is also to be noted that while the maximum affinity for Cl is at Al, that of O is at Si. It would be interesting to trace curves of intensity and quantity for other elements such as H and S. Much light might be thrown on many chemical facts.

(2) If we take the heats of combination of Cl, Br, or I, with any element, the law seems to be that the amount of heat diminishes as the atomic weights of Cl, Br, and I increase, modified, however, by the atomic weight of the element with which they combine. Thus, take what may be called the normal case, viz. combination with hydrogen, we have

Atomic weight of Br	= 80	of I	= 127
,, ,, Cl	= 35·5	Cl	= 35·5
Difference ...	44·5		91·5
Heat of combination HCl	= 22,000	of HCl	= + 22,000
,, ,, HBr	= 8,440	HI	= − 6,040
Difference ...	13,560		28,040

Now, 44·5 : 91·5 : : 13,560 : 28,040 almost exactly. With Al again the above differences are as under—

Heat of combination $AlCl_3$	= 160,980	of $AlCl_3$	= 160,980
,, ,, $AlBr_3$	= 119,720	AlI_3	= 70,590
Difference ..	41,260		90,390

Now it is evident these are not exactly in same proportion as the H compounds, and with Na and K compounds the discrepancy is even greater, but still near enough to suggest the general law as stated above.

(3) If the explanation given of crystallisation be correct, we may go a step further. If we take water alone without any salt in solution, there will be, in my view, attraction between the H_2 of one molecule and the O of another, and *vice versâ*, and if the heat of the liquid be diminished sufficiently, that attraction will cause cohesion of the molecules, and will produce solid water or ice, the regular structure of which is caused by the symmetrical arrangement of the atoms. This again leads on to solids in general, for there is little doubt that atoms of the same kind have affinity one for the other; and thus the various conditions of matter, solid, liquid, and gaseous, may be due to chemical affinity of the constituent atoms, modified in various ways by the kinetic energy of the system.

It will thus be seen that my view of chemical affinity is quite opposed to the idea of its being a sort of arbitrary force acting in units or bonds, but I consider it acts between all atoms of matter, whether of the same or different kinds in varying degrees of intensity and quantity, producing combination of more or less stability, graduating from the so-called mechanical mixture of clay and water up to the irresolvable molecules of the permanent gas, condensing by its action the gas into the liquid, and the liquid into the solid, chemical compounds being combinations in definite proportions of more or less stability. In fact, in this case as in all others, there are no hard and fast lines in Nature, but every phenomenon graduates by almost imperceptible degrees into another. W. DURHAM

THE JAPANESE NATIONAL SURVEY AND ITS RESULTS

DURING the past five years a work of great national and scientific importance has been proceeding in Japan; little has been heard of it in Europe, and none of its results have been visible amongst us in England until within the last few months. The Japanese National Survey, under the superintendence of Dr. Naumann, formerly Professor of Geology in the University of Tokio, has during the period above mentioned been steadily progressing; it has revealed hitherto unknown features of the country, and has thrown a flood of light on its geography, geology, and resources, actual and possible. A period has now been arrived at in the history of the Survey: its Director, after five years' labour at this particular work, and as many more in the Chair of Geology in the University of Tokio, returns to Europe, leaving the task to be carried out by the Japanese whom he has trained. Some tangible results of the work have, as already mentioned, been for the first time placed before the European public. In the rooms of the Royal Geographical Society might a short time ago be seen by any one who desired to do so a series of maps, printed and manuscript, with numerous plans, illustrations, and sketches, exhibited by Dr. Naumann, and representing to some extent the work of five years. Samples of these were also to be seen at the Exhibition of Geographical Appliances in Great Marlborough Street, amongst others an orographic map of Japan, and several illustrations—one of the mountain summits in the neighbourhood of the active volcano Asamayama being especially striking. The present, then, seems a suitable time for describing the Survey, the work it has set before it, that which it has succeeded in doing so far, and the effect of its work on our knowledge of the country.

When Dr. Naumann laid before the Japanese Government, about six years ago, the plan for a national survey, it was based mainly on economical considerations. It was pointed out that by means of such a survey the resources of the country, hitherto undeveloped, and to a considerable extent unknown, would be investigated systematically. At the commencement of the undertaking there were hardly any maps in existence that could be utilised with safety. The work was facilitated by the materials derived from a Japanese astronomical-geodetic survey carried out at the beginning of the present century, which fixed the position of the coast-line and the courses of some of the main roads. The coast surveys of the English Admiralty, also, and of the navies of other countries, as well as the few results of the trigonometrical survey of Japan, were found of use. But the interior of the country, in all that related to orography and geology, was still a *terra incognita*. In every other respect those rough Japanese compilations of older map-work of a mediæval type, though worked out by the application of some of the principles of European cartography, were totally insufficient. Hence at the outset it was necessary to undertake a topographical survey, so that not only matter, but also space, became the object of investigation. From the beginning the necessity of combining observations with measurements was emphasised. Inasmuch as the economical position of the country depends on agriculture, special attention had to be paid to the relations between the qualities of the soil and its cultivation. Hence the Survey started with three departments intrusted with field-work—one topographical, the second geological, and the third agronomical. A fourth, the chemical section, was created to investigate and test the materials collected by the geological and agronomical sections as to their composition and technical applicability. The plans laid before the Government, and approved, placed the scale of the maps, which were to be published in three series corresponding to the three divisions of the Survey—one topographical, one geological, and one agronomical, at 1 : 200,000. The maps were to be 0·456 × 0·277 metres for publication, and each series was to contain ninety maps, each of which corresponded to half a degree division, reckoned on the meridian of Greenwich. Two editions, one in English and one in Japanese, were to have been published. The scale for the field-work was 1 : 50,000. Subsequent experience demonstrated the substantial accuracy of these plans. It is of course essential in surveys like this that the various divisions should work side by side, and advance with equal and regular steps. But a consequence of the conditions under which work of this kind is conducted in Japan was that this co-operation, which was so necessary to the common aim, could not be carried out. The agronomical and chemical sections ultimately came under the sole direction of a Japanese Commissioner, and only the topographical and geological sections remained together under the immediate control of the Director who had laid the foundations of the whole undertaking. In order to understand the ill-effect of this division, it is only necessary to mention that the agronomical section worked on a different scale from the topographical and geological, and did topographical work for its own purposes, independent of that done by the topographical section!

The difficulties at the outset were numerous and important. First of all there were those connected with the nature of the work itself. The Japanese chain of islands is little more than a huge and complicated range of mountains, which is in parts hardly passable. Travelling along the main roads in Japan is not always very pleasant, but there are no particular hardships. Amongst the mountains, however, progress can only be made under great difficulties; and when a survey has to be made in these regions it demands all the energy and strength of a very strong man. It was necessary, too, in the present instance, in view of the economical wants of the country, to do the work in the shortest possible time. The period originally arranged was twelve years for the whole work; and what has been actually done since the beginning showed that it was possible to complete the Survey in this time had the staff been complete and the proposed organisation strictly disciplined for, and directed to, the purpose in hand, as might have been done. But, in fact, the staff never was complete, and the regular and constant prosecution of the Survey in course of time became more and more difficult, mainly owing to financial considerations. The year before last, for example, no field-work was done at all for this reason. At the outset, too, the training and educating of the assistants and cartographers presented great difficulties, which, owing to the energy and intelligence of the Japanese co-operators, were ultimately overcome. Again, when the stage of publishing was reached, obstacles of a peculiar kind were met with. To publish the maps abroad was not to be thought of. The Department had to pay the cost of publishing out of its own funds, and the work had to be carried out by Japanese. Experiments were made with lithography and heliogravure, but it is found impossible to adopt either of these methods in Japan. Ultimately the Toyodo Engraving Company in Tokio was intrusted with the work, under the constant superintendence and control of the director, and it is curious to note that the maps are all *etched* on copper, not engraved. Much more might be said of the difficulties which had to be overcome in this wholly new undertaking in Japan; but a commencement was made with the work towards the end of 1880. It soon appeared that the plans of the Survey could only be successfully carried out by a reconnaissance of the whole country in the first place. It appeared necessary to obtain first a general view of the conditions of Japan before the special and main work could be effectually commenced. The broad features, internal and external, of the mountain system of the country had to be ascertained, particularly for the purpose of allowing uniform representation in the special maps to be published later on. The Director commenced this preliminary survey early in 1881, and decided to prosecute it as far as possible in person. This reconnaissance was completed in the beginning of 1884, with a little help from assistants in regard to subordinate details. As an example of the work which this entailed, it may be mentioned that in two years he travelled, mostly on foot, 2000 miles, and that during the five years he was engaged in the work his routes covered about 5000 miles. The surveys in 1881 lasted from May to November, in 1882 from September to December, and the last great journey was from July 1883 to February 1884. The intervals which were spent in the capital were fully occupied; the orographical and geological sketch-maps (recently exhibited in London), as well as many others, were then produced. On this general survey of the country a topographical and geological map on a scale of 1 : 400,000, in five large sheets, was prepared. The first of these, embracing the topography of Northern Japan, has already been published, and might have been examined with others in the Royal Geographical Society. The other parts are in hand, and the record is doubtless already complete in manuscript.

Both in the reconnaissance and the principal survey, the method employed in the field-work was partly that of flying surveys. The main object was to obtain in the shortest possible time a view of the natural conditions of the country, and to produce a map which would be useful for economical and scientific purposes. The very detailed surveys of European countries could not, therefore, be taken as examples to be followed. The fundamental consideration was, above all, the economical requirements of the country. Even for military purposes in Japan, a smaller scale, allowing of the application of simpler methods and more rapid progress, is preferable for field and map work. In Tokio there is also a Survey Department attached to the General Staff, but it is based on Western methods, and on account of the very large scale adopted many generations must elapse before it is completed. In 1884, when disturbances broke out in the Saitama prefecture, the military authorities discovered their lack of maps, and they were compelled to obtain maps of the district from the Geological Survey. After this experience, and after the publication of the first sheets of the special map of the Survey, the General Staff would no doubt readily understand the advisability of a system such as that applied by the Geological Survey. During recent years in Japan interesting results were collected respecting the methods necessary for surveys where rapid progress is required. With regard, for instance, to the amount of work which can be performed in a limited time, the sketches exhibited in the Royal Geographical Society prove of much interest for military, exploring, and colonial surveys. It happens frequently that the practical geographer is compelled to explore or survey a given region in the shortest possible time. During the topographical and geological field-work of the Japan Survey, one of the most important rules observed was that of plotting the relations of space measured or observed in the particular places at once, and according to a definite scale (1 : 50,000). The first designs of the maps were, so to say, made in the field in the face of the objects to be represented. In this way the work of the topographer was made as independent as possible of that of the cartographer; under any other plan the final result would be more arbitrary. The amount of field-work done each day appears to reach the highest limit attainable. In 1881, for instance, Dr. Naumann surveyed, in some cases, routes of 32 kilometres in length, and this during the hottest summer months, and in difficult mountainous country. The daily average of Dr. Naumann during the reconnaissance surveys of 1881 amounted to 20 kilometres, while the average for the Japanese assistants was 12 kilometres. With regard to the degree of accuracy of the surveys thus made, it appears from an article on them, published in *Petermann's Mittheilungen* for January 1884, that the results, even with this great rapidity, were highly satisfactory. The route Miyako-Morioka, in Northern Japan, for example, shows an error of only 0·6 per cent. for the distance between the terminal points, which in a straight line is 68 kilometres, while the actual route surveyed is 100. For reconnaissance purposes this route was surveyed in five days.

At the commencement of the Survey the technical staff consisted of four Europeans—viz. a director, topographer, agriculturist, and chemist—and twenty-two Japanese assistants—viz. one geologist, five topographers, five agriculturists, five chemists, and six draughtsmen. The foreign chief of the agricultural section left the Japanese service at the beginning of 1881, and the foreign topographer a year later. The services of another foreign agriculturist were obtained at the end of 1883. At present the technical staff consists of two Japanese directors, one European in charge of the agricultural section, and thirty Japanese assistants. The results of the Survey are, in the first place, in the shape of maps, of which the following is a list:—

A. *General Maps on the scale of* 1 : 874,000 (at present in manuscripts.

(1) Geological map by Dr. Naumann and his geological assistants. On this map the distribution of the following geological groups and rocks shown:—Primitive gneiss (violet); crystalline schists (light rose carmine); Palæozoic group (neutral tint); Mesozoic group, Triassic, Jurassic, and Cretaceous (blue); Tertiary (light green); volcanic tuff, corresponding to very modern Tertiary (light yellow); granite, quartz porphyry, porphyry, porphyrite, diorite, diabase, and volcanic rocks.

(2) Oroplastic map by Dr. Naumann and his topographical assistants. The surface shape is represented by horizontal layers of 200 metres; the depths of the surrounding seas are shown on the same system. The mountains are marked by successive shades of brown, the sea by shades of blue. This map was in the late Exhibition of Geographical Appliances.

These two maps are mainly compiled from Dr. Naumann's reconnaissance surveys.

(3) Magnetic map by S. Sekino, representing the isogonic, isoclinic, and isodynamic lines of Japan, constructed from about 200 magnetic observations made at as many different stations.

(4) Map of the great historical earthquakes, volcanoes, solfataras, and hot springs of Japan, by Dr. Naumann and two of his assistants. The relative frequency of earthquakes in different parts of the country is indicated by different shades of brown. The limits of the areas of disturbance of some of the most remarkable earthquakes are likewise given.

B. *Maps Printed and Published.*

(5) Reconnaissance map, Division I., containing the northern part of the main island, from the original survey of Dr. Naumann and his assistants (Tokio, 1884). As already mentioned, this map is on the scale of 1 : 400,000. The mountains are represented by curves of equal height, 40 metres apart. The map is printed in three colours—the mountains brown, the water blue, while the skeleton and writing are black. The surface shape is clearly shown, and the system of representing the mountains is peculiar, and novel at least in a map of such small scale. The curves of equal height are directly used for the production of shades, which latter indicate the amount of slope. Great difficulty was encountered in reproducing this map. There can be no doubt that 40-metre curves applied to a 400,000 scale map represent the utmost limit attainable at present. In the case of an inclination of 45°, which occurs here and there, though rarely, the curves approach each other so closely that a zone of 1 mm. in breadth contains no less than ten lines! There are two different editions of the reconnaissance map—one with Roman, the other with Japanese, lettering. On other grounds all these maps are of interest, for they are the first artistic reproduction of the results of a regular topographical Survey in the far east of Asia.

(6) The three first sheets of the special Survey, showing the topography of the section Yokohama, Idsu, and Kadzusa. Here also there are two editions. Scale 1 : 200,000, and the mountains are shown by curves of equal height 40 metres apart.

(7) Index-sheet, containing the divisions of the whole country into five sections for purposes of the publication of the reconnaissance map, and into ninety sections for the special map. A short statement gives the progress of the Survey up to 1884, while the various signs employed in the maps are explained.

Besides the maps here specified, numerous designs, geological sections, landscape representations, tables, &c., have been made. A large number of practical reports were made for the Government, some of which have been published, but only in Japanese, and they are therefore inaccessible to the rest of the world. Among the papers thus furnished by the Director himself were reports on the waste of ores in Japan, on slate deposits and their utilisation, on Japanese building-stones, on the moving sand-dunes on the coast of Satsuma and how to fix them, on Japanese mineral springs, on the occurrence of gold and copper in various localities, and others.

As to the scientific results obtained by the Survey, they are of much general interest, but it is impossible in the space at our disposal to do more than refer to them cursorily. Those specially interested in the geological work may consult Dr. Naumann's book on the subject, "Bau und Entstehung der japanischen Inseln" (Berlin, Friedländer Sohn, 1885). Almost all systems have a part in building up the colossal mountain-range forming the Japanese islands. The occurrence of Devonian, Carboniferous, Triassic, Jurassic, Cretaceous, and Tertiary, was established by well-characterised fossils. A remarkable discovery of Upper Cretaceous Ammonites was made in the Island of Yezo, which Dr. Naumann proves are identical with Indian species of corresponding age. The considerable collection of Tertiary plants is now being studied by Prof. Nathorst, and his researches promise some interesting results, as appears from some preliminary notes already published by him. A monograph on Jurassic plants by Mr. Yokoyama, one of Dr. Naumann's assistants, will shortly appear. In early Tertiary times the Japanese islands contained numbers of elephants, identical with the celebrated species belonging to the old Indian Siwalik fauna (Dr. Naumann, "On Japanese Fossil Elephants," "Paläontographica," xxviii. 1). Triassic strata have yielded important fossils corresponding to the well-known *Monotis salinaria* of the Alps. Another important result of the Survey is the discovery of Radiolarian slates in almost every part of the archipelago. These are of great age, being probably older than the Carboniferous limestone, and they are nothing else than hardened mud of the deepest parts of the ocean bottom. Radiolarian mud occurs at present in depths of from 4200 to 8400 metres in the western and central parts of the Pacific Ocean, as ascertained by the *Challenger* Expedition. The mud, as well as the slates, is in great part made up of the microscopical skeletons of Radiolarians, and we learn that at remote periods the conditions at the greatest depths of the ocean have been nearly the same as at present, and that in Palæozoic times a great part at least of the Japanese chain was deeply submerged beneath the sea. Great scientific value must also be attributed to the results respecting tectonic geology, which are perhaps the most prominent of all. The Japanese island chain is one of the finest examples of a mountain-range of unilateral structure; and there cannot be the slightest doubt that it has been shifted by forces acting from the side of the Japan Sea towards the side of the free ocean. Almost all the eruptive and volcanic rocks are confined to a zone facing the Sea of Japan, while the outer zone is for the greater part made up of folded larger masses of Palæozoic and pre-Palæozoic times. Very striking, too, is the great transverse depression, introduced by Dr. Naumann into scientific nomenclature by the name of Fossa Magna, which crosses the main island not far from the capital. It appears that this depression is a kind of fissure or cleft produced by another chain of mountains running from Vries Island to the Bonin Islands. The movements going on in this latter chain may have entered the Japanese chain so as to split it. Some of the largest volcanoes of the country—as for instance the celebrated Fujinoyama—issued from that fissure. An inspection of the geological map shows clearly how the advancing folds were stopped by the Fossa Magna, so that they curve back and go around it. Last, but not least, the results concerning the magnetism of the earth may be mentioned. As shown in the magnetic map mentioned above, the magnetic curves are curiously irregular, and these irregularities have an evident connection with those of the geological structure. The Fossa Magna causes the isogonic lines to describe a large irregular curve, like the folds of the geological strata. Dr. Naumann, we believe, is preparing a paper on this subject for the Royal Society, where a fuller treatment of this phenomenon than he has hitherto given may be anticipated.

It is to be regretted that the Japanese Government does not appear sufficiently aware of the importance of a work such as that carried out by its Geological Survey. Its economical value is probably that which would appeal most strongly to a Government, and of its utility from this point of view there can be no doubt. The fundamental ideas with which the undertaking started should be revived: the various sections of the Survey must advance with even step, otherwise the work cannot fail to be irregular and dislocated. It may be hoped, too, that the Japanese will know how to utilise the invaluable experience laboriously collected by the Survey during the past five years.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—An Examination for Minor Scholarships at Downing College will be held early in June. These Scholarships will be awarded for Law, or certain branches of Natural Science. Persons who have not entered at any College in the University are eligible to these Scholarships, which will be of the value of 50*l*., and tenable until their holders are of standing to compete for a Foundation Scholarship. Further information will be given by the Tutors of the College.

SCIENTIFIC SERIALS

Archives Italiennes de Biologie, tome vii., fasc. 1, Rome, February 1886, contains:—Studies on the drainage of the Roman Campagna, part 5, by C. Tommasi-Crudeli, concludes with the expression of his opinion, based on very numerous facts—(1) that the proposed artificial draining of the Ostian and Maccaresan marshes, and their reclamation, will augment in a great degree the malaria exhalations from these basins; and (2) that the hygrometric condition in which the subsoil of the reclaimed district would exist would render it very probable that such malaria exhalations would be persistent. He believes that malaria is produced on the earth, and not on the water, and when an area is covered with a sheet of water, and while it is covered, it is free from malaria.—On the minute anatomy of the central nervous organs, by Prof. C. Golgi.—On periodic and superfluous respirations, by Prof. A. Mosso (eight plates).—The respiratory movements in health are not always uniform in sleep and during moments of deep repose; the respiratory effort decreases and augments. This peculiar form the author calls "periodic respiration," and any excess of respiration beyond the actual needs of the tissues and blood he calls "superfluous respiration." Many phenomena of interest are described in this memoir.—Contribution to a knowledge of the physiological effects of cocaine, by Dr. C. Sighicelli.—On the physiological action of thalline, by Dr. G. Pisenti.

Schriften der Naturforschenden Gesellschaft in Danzig, Band vi. Heft 3 (1886).—We note here a copiously-illustrated account by Drs. Lissauer and Conwentz of the various antiquities which have been found in the Vistula-Nogat delta, ranging from the Neolithic period to Roman times; also a curious collection, by Herr Triechel, of sayings of the country folk in West Prussia, about plants.—Herr Helm and Herr Brischke report on insects found in amber.—The remaining matter largely relates to local botany.

Bulletin de l'Académie Royale de Belgique, February.—Application of the telephone to the discovery of faults in electric lines, by Eric Gerard. A new and ingenious method is described for determining by means of the telephone the spot where an underground telegraph line presents any accidental solution of continuity without the necessity of opening the ground and exposing the section of the wire where the break is suspected to exist. Owing to its extreme sensitiveness, the telephone communicates all signals transmitted by the underground conductor during the examination; but when the fault is reached, it remains silent, thus indicating the spot where search should be made for the defect. The method may be made applicable to submarine cables.—Earth microbes and their action in stimulating the growth of the higher vegetable species, by E. Laurent. In order to ascertain how far these micro-organisms are necessary to the life of the plant, the author has recently made some experiments: (1) in natural soil; (2) in soil first sterilised and then inoculated with microbes taken from the natural soil; (3) with soil rendered absolutely sterile; (4) with sterilised soil to which mineral manures were afterwards added. These experiments clearly showed the importance of the microbes, whose functions would seem to be identical with those of nitrification. They seem to prepare the needed inorganic food of the plant by decomposing the organic matter present in the ground.—On the influence of lunar attraction on the mercurial barometer, by J. Liagre. This was in reply to some remarks of M. Folie, who questioned the author's statement that atmospheric tides cannot be determined by the mercurial barometer. He repeats that lunar attraction cannot be appealed to in order to explain M. Folie's law that atmospheric pressure is lowest when the oceanic tides are highest.—A simple and practical method of determining the magnetic declination of any place whose meridian is unknown, by F. Folie. It is shown that the difficult and troublesome process of fixing the meridian may be dispensed with by employing a method based on the simple fact that, when the height of a star is equal to its declination, taken with its sign or opposite sign according as it is in the northern or southern hemisphere, its azimuth is the supplement of its horary angle, or else is equal to this angle itself.—Notice of some geological specimens from the islands of Cebu and Melanipa (Philippines), by A. F. Renard. A study of these specimens, collected by Mr. Buchanan in 1874, seems to show that to Cebu and Melanipa may also be extended the interpretation already admitted for the larger islands of the archipelago regarding the schisto-crystalline character of the underlying rocks, and the presence of eruptive rocks of the archæan type.—The same author contributed two other valuable papers on the geological constitution of the Ternate volcano and of Mount Gûnong-Api, in the Banda Archipelago.

Rendiconti del Reale Istituto Lombardo, March 4-18.—Positivism and evolution, by Prof. A. Buccellati. It is argued that Comte's theological, metaphysical, and positive cycle may perhaps represent the general sequence of mental evolution, but cannot be accepted in a strictly chronological sense. It confines the human mind in too narrow limits, and it must be obvious that all three phases of thought have been simultaneously at work in varying degrees of intensity at all times. Such an exclusive succession is illogical, and opposed alike to history and to the very constitution of the mind, which passes readily and unconsciously from analytic observation to synthesis, and from the inductive to the deductive method.—On the systems of surfaces and their rectangular trajectories, by G. Morera.—Meteorological observations made at the Brera Observatory, Milan, during the month of February.

SOCIETIES AND ACADEMIES

London

Royal Society, March 25.—"On the Minute Anatomy of the Brachial Plexus." By W. P. Herringham.

Dr. Herringham had traced by dissection the fibres of the several nerve roots from the spinal cord through the net of the plexus into the various nerves given off from this, and down these nerves to their final destination, whether motor or sensory. He found—

(1) That any given fibre may alter its position relative to the vertebral column, but will maintain its position relative to other fibres.

(2) That, in the motor nerves, (*a*) of two muscles, or of two parts of a muscle, that which is nearer the head end of the body tends to be supplied by the higher, that which is nearer the tail end by the lower nerve; (*b*) of two muscles that which is nearer the long axis of the body tends to be supplied by the higher, that which is nearer the periphery by the lower nerve; (*c*) of two muscles that which is nearer the surface tends to be supplied by the higher, that which is further from it by the lower nerve.

(3) That, in the sensory system, (*a*) of two spots on the skin that which is nearer the pre-axial border tends to be supplied by the higher nerve; (*b*) of two spots in the pre-axial area the lower tends to be supplied by the lower nerve, and of two spots in the post-axial area the lower tends to be supplied by the higher nerve.

A table was also given of the muscles classified according to the spinal root which supplied them. The paper was based on fifty-five dissections.

Physical Society, April 10.—Prof. Balfour Stewart, President, in the chair.—The following communications were read:—On the cause of the solar diurnal variations of terrestrial magnetism, by Prof. Balfour Stewart, LL.D., F.R.S. The author commenced by reviewing various theories that have been advanced to account for the solar diurnal inequalities of terrestrial magnetism. That they can be due to the direct magnetic action of the sun is highly improbable, since terrestrial analogies would lead us to infer that matter at the temperature of the sun is quite incapable of possessing magnetic properties, and also from the fact that changes in the range of the daily variation lag behind corresponding solar changes in point of time. The hypothesis of Faraday, that the observed variations are the result of the displacement of the magnetic lines of force due to the varying temperature, and consequently varying magnetic permeability, of the atmospheric oxygen, is disproved by the fact that there is no agreement between the chief magnetic variations and those of the temperature of the great mass of the atmosphere, though it is certain that there must be some effect due to this. The earth-current hypothesis is quite unable to explain one of the chief characteristics of these variations, that they are half as great again at periods of maximum as at those of minimum sunspot frequency. Sir George Airy has, moreover, been unable to detect any resemblance in form between the regular diurnal progress of the magnet and that of earth-currents. We seem, therefore, compelled to seek for the cause of the variations in the upper atmospheric regions, and we cannot imagine such a cause to exist in any other form than that of a system of electrical currents. That curents may, and actually do, exist at great heights is shown by the aurora, which is unquestionably an electric current, and manifests a close connection with the phenomena of terrestrial magnetism. The great increase of magnetic variation at epochs of maximum sunspot frequency can also be accounted for on this supposition: Prof. Stokes has remarked that an increase in the radiating power of the sun would probably imply not only an increase in general radiation, but a special and predominant increase in such actinic rays as are probably absorbed in the upper regions of the earth's atmosphere. These regions will, therefore, greedily absorb the new rays, their temperature will rise, and, as is known to be the case for gases, the electrical conductivity will be increased.

Thus, even if we imagine the general atmospheric current to remain constant, a greater proportion of it would be thrown at such times into those heated portions which had become good conductors, but it is also probable that the current itself would be increased. Assuming the existence of currents at great altitudes, the regularity and general characteristics of the diurnal variations would seem to point to a direct magnetic action of the currents rather than to any general induced change in the magnetic system of the earth, which, to produce the observed results, would have to be of a very artificial character. The diurnal variation of the declination, attaining a westerly maximum at 2 p.m. north of the equator, and an easterly maximum at the same time south of it, would suggest the existence of currents flowing northward and southward from the equator to the poles, attaining a maximum in each hemisphere about two hours after the sun had passed the meridian. To supply this flow we should probably have to assume the existence of vertical currents ascending from the equatorial regions of the earth. At this point Dr. Schuster has endeavoured to apply mathematical analysis to the subject. From the recorded observations at Greenwich, Lisbon, Hobarton, St. Helena, and the Cape, he has shown that the work done by a magnetic pole describing a closed path in a horizontal plane at those places is equal to the work done upon it, and consequently no part of the ascending current can be inclosed by the path. Hence the potential at those places obeys the law expressed by the equation—

$$\frac{d^2V}{dx^2} + \frac{d^2V}{dy^2} + \frac{d^2V}{dz^2} = 0.$$

From this Dr. Schuster has deduced two possible expressions for the potential, one referring to a system of currents above our heads, and the other to one beneath our feet. From the first of these expressions it follows that for latitudes greater than 45° the maximum of horizontal force should coincide with the minimum of vertical force, and *vice versâ*, and this is actually the case at Greenwich; while the opposite should hold if the influencing system were beneath us. For latitudes below 45° the reverse of the above should be the case, and the observations at Bombay, though less decided than those at Greenwich, would seem to point the same way. On the whole, then, it must be said that the results of the first attempt are very encouraging, and point to the supposition that the greater part of the disturbing cause lies outside the earth's surface. In a discussion that followed, Mr. Whipple remarked that recent observations in high latitudes seem to show that the aurora is not always at such a great height as is usually supposed. Prof. A. W. Rücker cited the well-known case when an observer saw what appeared to be a meteor fall into the sun, while simultaneously, or nearly so, there was recorded a magnetic disturbance on the earth, as showing a direct solar action. Mr. Whipple, however, stated that he had recently examined this point, and believes that the very slight notch in the record, many similar to which have occurred since, was of an accidental nature, and a mere coincidence. Prof. McLeod suggested that the earth-current theory might be tested by observations at the bottom of a mine, where, according to the theory, the disturbances should be reversed. Prof. Adams believed that there was nothing physically impossible in the existence of such currents as the author imagined.—On a relation between the critical temperatures of bodies, and their thermal expansions as liquids, by Prof. A. W. Rücker, F.R.S., and Prof. T. E. Thorpe, Ph.D., F.R.S. A paper by the authors bearing the above title was published in the *Journal* of the Chemical Society of London for April 1884. The substance of the paper was as follows. Prof. Mendeléeff has shown that the expansion of liquids under constant pressure between 0° C. and their boiling-points may be expressed by means of the very simple formula—

$$V_t = \frac{1}{1 - kt},$$

V_t being the volume at $t°$ C. (that at 0° C. being unity), and k a quantity which differs for different substances, but which may for any one substance be considered invariable between 0° C. and the neighbourhood of the boiling-point. From this law the authors have obtained as a deduction the following expression for the critical temperature (T_c) of any liquid—

$$T_c = \frac{TV_t - 273}{a(V_t - 1)},$$

where V_t is the volume at $t°$ C., T the absolute temperature, and a a quantity which is very nearly constant for all substances, and which was shown to be very nearly 2.—In a recent paper (*Ann. Ch. Ph*, March 1886) MM. A. Bartoli and E. Stracciati have discussed both of these formulæ, and have applied them to cases in a manner never intended by the authors. They have expanded Mendeléeff's formula into the series

$$V_t = 1 + kt + k^2t^2 + k^3t^3 + \ldots$$

which is a geometrical progression, and they have objected to it that the results of Pierre, Kopp, Hirn, Thorpe, &c., do not give for the coefficients of t, t^2, t^3, quantities in geometrical progression. The results of these observers are given in the usual form—

$$V_t = 1 + at + bt^2 + ct^3 + \ldots$$

but, owing to unavoidable errors of experiment, the constants c, d . . . of different observers differ very largely, and Mendeléeff's simple expression gives the results of all quite as accurately as the facts will allow. MM. Bartoli and Stracciati have then criticised the expression given by the authors, and have applied it to determine the critical temperature of water from its expansion to 200°, whereas the original expression is only given as applicable as far as the boiling-point. They have further recorded a number of critical temperatures calculated by the formula to tenths of a degree, for which the constant a would require to be known to ·025 per cent., whereas there is no reason for supposing it known to within 1 per cent. or more.

Zoological Society, April 6.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary exhibited, on behalf of Mr. J. B. Martin, F.Z.S., a large tusk of the Indian Elephant (*Elephas indicus*), about 6 feet long and weighing over 100 lbs., stated to have belonged to a "rogue elephant," with only one tusk, which had been killed at Goruckpore in 1836.—Mr. Sclater exhibited the heads and horns of two species of Antelopes obtained in the vicinity of Lamoo, East Africa, belonging respectively to *Strepsiceros imberbis* and *Damalis senegalensis*.—Mr. F. E. Beddard read a paper on some points in the anatomy of *Chauna chavaria*.—Prof. Flower communicated a paper, by Miss Agnes Crane, on a Brachiopod of the genus Atretia, from Port Stephen, Australia, described in manuscript by the late Dr. T. Davidson, and proposed to be called *Atretia brazieri*.—Mr. J. G. Goodchild, H.M. Geological Survey, read a paper on the disposition of the cubital coverts in birds. This communication described the principal modes of imbrication of the cubital coverts, as observed in healthy living birds of all the leading carinate forms, and pointed out that there is a certain correlation between particular styles of imbrication and various other characteristics connected with the pterolysis, the myology, the visceral anatomy, and osteology of the birds in question. The paper concluded with some observations upon the origin of the features described.—A communication was read from Dr. Günther, F.R.S., containing some further information on the melanotic variety of the South African Leopard which he had previously described.

Geological Society, April 7.—Prof. J. W. Judd, F.R.S., President, in the chair.—Edward George Aldridge, Charles Brownridge, James Dennant, Charles Lane, Prof. H. Carrill Lewis, and William Matthews were elected Fellows of the Society.—The following communications were read:—On glacial shell-beds in British Columbia, by G. W. Lamplugh. Communicated by Clement Reid, F.G.S. This paper was divided into two parts, relating respectively to Vancouver Island and the Fraser Valley. Having to spend nearly a month at the city of Victoria in 1884, the author had leisure for the investigation of the geological features of the district, but he expressed his regret that, at the time, he was unacquainted with the publications of Mr. Bauerman and Dr. Dawson on the subject. The most important shell-beds were disclosed in an excavation for a dry dock at Esquimault, V.I. Here a fissure in an igneous rock had been filled in by glacial beds. Shells were most numerous on the north side of the dock in Boulder-clay, associated with irregular sandy seams, the whole being softer than the general mass. The containing rock was not glaciated at this point. Leda, Nucula, Cardium, Tellina, Mya, and Saxicava are the principal genera. There was great difference in the state of preservation according to position; the shells below the water-line being remarkably fresh, while acidulous waters engendered by vegetable decay had attacked the upper portions. The author concludes that the whole mass of drift, including the shells, had been pushed up by ice in its passage southwards.

The general mode of occurrence was very similar to that at Bridlington. He further observed that the rocks were not striated in the first instance by these shelly clays, but he believed the glaciation to have taken place through the action of harder substances, and that afterwards a milder term set in, when an Arctic fauna established itself in the neighbourhood, after which fresh ice pushed the sea-bottom along with other accumulations into its present position. The shell-beds in the Fraser Valley are about 100 feet above sea-level. Three sections of glacial beds were given. The stratified clay in which the shells were found contains no pebbles, and, though somewhat disturbed, has evidently been deposited where it now occurs.—On a lower jaw of Machærodus from the "Forest-Bed," Kessingland, by James Backhouse, F.G.S.—A contribution to the history of the Cetacea of the Norfolk "Forest-Bed," by E. Tulley Newton, F.G.S.

EDINBURGH

Scottish Meteorological Society, March 29.—Half-yearly Meeting.—Mr. John Murray read the Council's report, which stated that since last July the only change that had taken place in the Society's stations was the loss of the station at Sandwick, in Orkney, and the establishment of a new station in the neighbourhood, at Swanbister. The three Members of Council who retired by rotation were Dr. J. B. Russell, Glasgow; Dr. J. D. Marwick, Town Clerk, Glasgow; and Prof. Alexander Dickson; and their re-election was recommended. In July last the membership of the Society was 698; it was now 712. In addition to the inspection of stations and the ordinary work of the Office, the Secretary had been engaged with the discussion of the Ben Nevis observations, and the work was now far advanced. Some time had also been given to the preparation of a fourth paper on the climate of the British Isles, dealing with the mean monthly distribution of the rainfall, based on the twenty years from 1866 to 1885. Mr. Omond was also engaged in the discussion of the Ben Nevis observations. During the summer and autumn the Observatory on the Ben had been utilised by Mr. H. N. Dickson for hygrometric observations; and Prof. Vernon-Harcourt and Mr. Harold Dickson, both of Oxford, had also spent some time at the Observatory in August conducting experiments and observations on the intensity of light in flames. The researches at the Scottish Marine Station were being prosecuted with vigour and success. Messrs. Mill and Morrison were engaged in collecting and tabulating all the observations which had been made around the coasts, and combining them with those made by the observers in connection with the Marine Station, the object being to obtain a more exact statement of the temperature conditions of the sea around the coast at different months of the year and at different depths. Observations had also been continued on the Firth of Forth by these gentlemen with very interesting results. It was shown by Mr. Mill on a former occasion that the winter condition of the Firth was one of uniformly-rising temperature from the river to the sea, and from the surface of the water to the bottom; while the summer condition was one of uniformly-falling temperature from river to sea, and from surface to bottom. The winter condition commenced in September 1885, nearly two months earlier than in 1884; the temperature of the water had been everywhere lower than in the winter of 1884-85, and at the present date there was no sign of the transition to the summer state. Two gentlemen in the north had been observing the temperature of the River Thurso at the mouth, and at a point twelve miles inland. The river, it is shown, responded rapidly to changes of temperature. During the greater part of the winter the water kept close to the freezing-point, though never actually freezing, except at the margin; while the sea had been uniformly from 10° to 5° warmer than the river, and its temperature had never been below 40°.—The Treasurer, Dr. Sanderson, stated that a member, who did not wish his name disclosed, had given 100*l.* to be distributed—50*l.* to Mr. Omond, 30*l.* to Mr. Rankin, and 20*l.* to Mr. Miller. The donation was "in acknowledgment of their services in the important work in which they were engaged, from an admirer of their indomitable pluck."—An interesting paper by Mr. Omond was read on the rainfall and winds at Ben Nevis Observatory. The winds, arranged in order of greatest frequency, are N., S.W., W., S.E., S., N.E., N.W., and E.,—the N.E. and E. winds being remarkably few in number. In their relation to the rainfall, the order of the winds for wetness is W., N.W., S.W., N., S., N.E., S.E., and E. The direction from which most rain came during 1885 was probably a little to the north of west, and the quantity diminishes as we go round the compass in both directions, until the driest point is reached a little to the south of east, the east winds having thus a very low figure both as regards frequency and the quantity of rain precipitated by them. Again, arranging the data for the amount of rainfall per 100 hours of each wind, the following is the order: N.W., W., S.W., S., N., N.E., S.E., and E.,—the E. and S.E. winds being very dry. With a falling barometer the average daily rainfall amounted to 0·587 inch, while with a rising barometer it was 0·483 inch. —The next paper was on rain-band observations on Ben Nevis, by Mr. Rankin, first assistant at the Observatory. The observations have been made on a scale of 0 to 5, and the mean results of the rainfall for three and twelve hours respectively after the observations showed that the rainfall increased steadily in amount with the figures of the scale. Grouping the observations according to season, it is shown that the subsequent rainfall was less with a higher, and greater with a lower, temperature. Very interesting observations were referred to, which were made in those states of the atmosphere, of no infrequent occurrence on the Ben, when aërial strata of great dryness and of complete saturation are superimposed on each other. —In a paper on the recent literature of the rain-band, Mr. H. R. Mill remarked that, although the spectroscope had been shown by many observers to give 80 per cent. of rain or of no rain occurring in a given time, results of great scientific value could only be expected when, as at Ben Nevis Observatory, it was combined with a complete series of hourly meteorological observations.—Mr. Buchan gave, in reference to the weather of the past winter, a short analysis of the temperature of Scotland during the past 122 years. During this long period the last 15 years showed the coldest 15 consecutive summers. Each of the 15 Junes was below its average temperature, except June 1873, which was 0°·2 above it. The mean of the Mays was 1°·6 under the average; the Junes 1°·2; and each of the other months from April to December from 0°·4 to 0°·9 under the average. The means for January, February, and March were above the average. During these 122 years there had occurred 38 hard winters, extending from two to six months each. Of these 38 winters 18 were followed by good summers and 20 by bad summers, and while of the 18 good summers 2 may be classed, in respect of the temperature, as very good, 8 of the 20 bad summers were very bad, and proved most disastrous to the grain crops.

PARIS

Academy of Sciences, April 19.—M. Jurien de la Gravière, President, in the chair.—Note on some new methods for determining directly the absolute value of refraction at various degrees of altitude, by M. Lœwy. After brief reference to the ordinary methods, including one recently proposed by the author himself, the paper goes on to explain a new process by means of which the refraction may be directly determined at all degrees of altitude,—an operation hitherto supposed to be impossible. It concludes with the description of a method for immediately ascertaining the effect of temperature and barometric pressure on refraction.—On the diurnal variation in direction and intensity of the magnetic force in the horizontal plane at Greenwich, as deduced from Sir G. B. Airy's observations made during the years 1841–76, by M. Faye. The author deals with the important series of diagrams appended by the Astronomer-Royal to the volume of Greenwich Observations for 1884, embodying the diurnal variations in horizontal direction and intensity of the terrestrial magnetic force for the thirty-six years ending in 1876 inclusive. As a general result it would appear that the magnetic curves, as exhibited in the 430 diagrams of Sir G. B. Airy's series, contract and expand periodically in direct agreement with the greater or less prevalence of the solar spots, and also with great regularity according to the seasons, the summer curves being invariably far greater than those of winter.—On the remains of fossil reptiles discovered by M. Fritsch in the Permian formations of Bohemia, by M. Albert Gaudry. These fossils, now collected in the Palæontological Museum of Prague, are grouped in twelve genera representing a whole series of quadrupeds of a comparatively high order, obtained in strata where, till lately, no animals had been found higher than the order of fishes. Compared with those of the Secondary epoch, all these Primary reptiles are of small size and imperfect development, inferior in these respects to the Actinoderm, Enchirosaurus, and Stereorachis found in the bituminous schists and other formations of corresponding age in France.—On the fluorescence of the earths provisionally named $Z\alpha$ and $Z\beta$, by M. Lecoq de Boisbaudran. In opposition to the views of Mr. Crookes, the author endeavours to show that these are really two distinct earths, not one substance identical with Mr. Crookes' Yt_2O_3, whose different fluorescent bands become diversely modified by the presence of foreign bodies.—On M. Marignac's earth $Y\alpha$, by M. Lecoq de Boisbaudran. At the author's suggestion, M. Marignac, discoverer of this rare earth, has at last definitely named it *gadolinium* (symbol Gd).—A second note on the origin of the electric discharge of thunder-clouds, by M. Daniel Colladon. A remarkable coincidence is pointed out between the author's observations and some electric phenomena observed at the same time near Shrewsbury, and reported in the *Monthly Meteorological Magazine* for September 1885.—On a mathematical essay by Prof. Battaglini, presented to the Academy by M. de Jonquières. This is a reprint from the *Giornale di Matematiche*, containing a demonstration of the theory of Cremona transformations, with some fresh developments of the same theory.—On the blight known as *taches nécrosées*, which attacks the peach-trees in the fruit gardens of Montreuil and other districts near Paris, by M. Prillieux. The cause of this local disease is traced to a parasite of the order Coryneum. Solutions of salts of copper or diluted sulphuric acid are proposed as remedies.—On the results of direct astronomic observation compared with those obtained from MM. Henry's photographic system, by M. Flammarion. The discrepancies between M. Wolf's chart and MM. Henry's photographs are attributed to errors of observation on the part of M. Wolf, and the author concludes that the photographic record is far more accurate and altogether more trustworthy than direct observation. The ten stars marked on M. Wolf's chart, but which do not appear on the photographs, are stated to have no existence in the firmament.—On the reduction of the Abelian integrals, by M. H. Poincaré.—Theorem on the binary forms, by M. d'Ocagne.—On the thermo-electric properties of the iodide of silver, by M. H. Le Chatelier.—Note on the vanadates of ammonia, by M. A. Ditte. The paper deals with neutral vanadate, bivanadate, yellow and red trivanadate, and other combinations formed by ammonia and vanadic acid.—Transformation of the protochloride of chromium into a sesquichloride: mechanism of the dissolution of the sesquichloride of anhydrous chromium, by M. Recoura.—On the acid fermentation of glucose, by M. Boutroux. The cause of fermentation is traced to a micrococcus greatly resembling the organism already described by the author under the name of *Micrococcus oblongus*.—A further survey of the vegetation of South Tonquin, by MM. Ed. Bureau and A. Franchet. The paper deals with a collection made in the hilly district south-west of the Song-Koi delta, by the Abbé Bon, and presented to the Paris Natural History Museum by the Abbé Hy. It comprises 857 species grouped in 124 families, and tends to confirm the impression that the flora of Tonquin has no special features, but forms a transition between those of China and India.—A new example of alternating generations in the fungus family (*Cronartium asclepiadeum* and *Peridermium Pini corticolum*), by M. Max. Cornu.—On the acrogenous development of the reproductive bodies in the fungus family, by J. de Seynes.—On the theory of earthquakes, by M. Stanislas Meunier. A number of fresh observations are advanced in support of the author's view that underground disturbances and eruptions are primarily due to the infiltration of surface-waters.—On the geology of East Tonquin, by M. E. Jourdy. From a protracted study of this region the author infers that in the interior the Carboniferous underlies the Triassic formation, while on the coast the Coal-Measures, here of infra-Liassic age, rest directly on the Carboniferous limestone in one of its folds.—On the disappearance of the nuclear chromatic elements and progressive appearance of the chromatic elements in the equatorial zone, by M. Ch. Degagny.—On the mycosic nature of tuberculosis, and on the bacillary evolution of its pathogenic fungus, *Microsporon furfur*, by MM. Duguet and J. Héricourt.

BERLIN

Physiological Society, February 12.—Dr. Müllenhoff informed the Society that a treatise of the great astronomer Kepler had quite recently come under his notice, containing, under the title of "Neujahrsgeschenk, oder der sechsstrahlige Stern des Schnees" ("New Year's Present, or the Six-rayed Snow-Star"), a very clear and accurate description of the structure of the bee's cell. Kepler described the bee's cell as a rhombendodecahedron in which one trihedral pyramid was replaced by a straight terminal surface. The speaker further set forth the observations he had made on the way in which bees filled and preserved in their cells honey and pollen. The bee, which, according to the most recent determinations of Dr. Loew in the Botanical Gardens of Berlin, was able to force its way into most flowers, having first completely filled its capacious honey-stomach, crept into the cell, and, with its tongue, licked a small spot of the posterior uppermost edge many times, and on this spot, so moistened, it deposited a honey-drop. On this honey-drop other bees next discharged their honey till the whole cell was filled with the viscid liquid. Eight bees sufficed to fill one cell. Each deposited honey-mass got covered with a kind of pellicle that at a small spot was bitten through by the next succeeding bee, which then laid its honey at this opening, the honey penetrating into the interior. The filled cell was closed with a wax lid. The pollen brushed off the blossoms by the bees was, by admixture of a little honey or water, converted into a dough-like substance, and pressed into cells intended only for working bees till they were half filled. The rest of the cells were then filled with honey in the same manner as were the pure honey-cells. Finally these too were closed. When the cell was filled either with honey or with pollen-dough and honey, a drop of formic acid secreted from the poison-gland was infused through the lid by means of the sting. This formic acid, as had been proved by numerous experiments, preserved the honey, as also every other solution of sugar, from fermentation. Indeed formic acid in the proportion of 1/10 per cent. was altogether a very good preservative. Pollen, which was not covered with honey, got very soon mouldy.—Dr. Benda made further communications respecting spermatogenesis, first premising that the observations of his own which he communicated at the last meeting (*vide* NATURE, February 11, p. 360) had been published some months prior to that date by an English investigator, Herbert Brown. The similarity between the drawings of Mr. Brown and his own was striking. If he had thus been forestalled in the discovery of the new facts by his English contemporary, he had yet been able to observe a series of further details beyond the limit of what had hitherto been ascertained, several of which he communicated.—Dr. Gad had been engaged for a number of years in experiments on respiration, and both in those experiments carried out by himself and in those executed by his students he had obtained the same results. The problem was to establish whether the centres situated in the medulla oblongata and above it in the brain automatically discharged the movement of inspiration and expiration or only stimulated one group of respiratory muscles, actions which were to be characterised as normal excitations due to automatic activity and proceeding from the blood, not operating in a reflex manner. These centres were usually called automatic, but in the opinion of the speaker they would be more correctly described as autochthonous, seeing they were excited only at the particular place and spot, and not set in motion by any stimulus derived from the outside. To study the normal activity of these centres Dr. Gad examined the respiratory processes in the primary stage of dyspnœa, when the medulla oblongata was ill-supplied with air. The bad ventilation was brought about either by the animals having breathed the air so long that they were obliged to inhale air that was now grown vitiated, or having to breathe a mixture of nitrogen with less oxygen than was contained in atmospheric air, or a mixture of atmospheric air with carbonic acid; or the normal exchange of gas was restricted by tracheostenosis, or by heavy bleedings, or by the Kussmaul-Tenner experiment, in which, as was known, the flow of arterial blood to the brain was dammed off. In all the cases above enumerated, only augmented inspiration was always observed—never increased expiration. In the Kussmaul-Tenner experiment a lassitude of the inspiration set in very soon before the spasms had yet begun, a circumstance which called forth the appearance of an enhanced expiration. The method adopted in these experiments was considered by the speaker unobjectionable. Into the trachea of the rabbits there was fixed a cannula, which, by means of a double-direction tap, might be connected with the outer air or with very large gas repositories. The animal found itself in a small closed air-proof box communicating with a small, shallow box, the upper lid of which consisted of a movable mica plate, with recording lever. Each inspiration of the animal raised the lid, and consequently the recording lever, which marked on a rotating drum the curve of respiration. At each expiration the lid sank with the pen. Dr. Gad concluded from his experiments that, by bad ventilation of the respiratory centres automatic or autochthonous expiration could never be induced, but always inspiration alone. Dr. Gad further endeavoured to ascertain what was the limit of deficiency of oxygen and of carbonic acid admixture under which the first traces of dyspnœa showed themselves, and found that the animals were more sensitive to the excess of carbonic acid than to the deficiency of oxygen. An addition of 3 per cent. CO_2 was sufficient to excite dyspnœically augmented inspiration, while they could very well stand an air of 18 per cent. oxygen. The quantities of CO_2 which were mixed with the respiratory air were increased to 26 per cent. without the result being other than increased inspiration. Regarding the several series of experiments and their results, Dr. Gad would communicate a more special report at a subsequent meeting.

Meteorological Society, March 2.—Dr. Weinstein spoke on the earth's currents which were observable in the telegraph wires by the disturbances they caused in the message service, their intensity at times exceeding that of the batteries of eighty Daniell employed for telegraphing. In order to the observation of the earth's currents, two equal metal plates had since the time of Faraday been sunk into the ground and connected by a wire, in which a galvanometer was intercalated. The deviations of the galvanometer needle might be induced as well by an earth-current as by a current which arose from the contact of the earth-plates with the earth. In the latter case, however, the current would be very weak when the plates were at a great distance from each other. The case being, in point of fact, otherwise, however, the currents in question were accordingly earth-currents. The measurement of them was achieved by means of self-registering apparatus, either in the way of photography in England or mechanically in Germany; the earth-current was conducted through a coil, that, suspended in the interval between a rod magnet and a hollow cylinder magnet, was, under the oscillations of the current, drawn in or pushed out, and, by means of a lever, inscribed these movements on soot-blackened paper. The direction of the current in the body of the earth was found by observation of two circuits forming a right angle with each other. In Berlin one circuit proceeded eastwards towards Thorn, the other southwards towards Dresden. The observations made in Berlin showed a direction of the earth's current from north-east to south-west, while in England the direction went more from north to south with a slight deviation towards the east, and in France a direction from north to south with an inclination towards the west was observed. The earth-current showed a perfectly regular daily variation. In the night the earth-current is slight; from 8 o'clock in the morning it regularly increases, attains its maximum precisely at 12 noon, thence sinks rapidly till 4 p.m., whence it continues uniformly weak, not to revive till the following morning. A course precisely analogous to that of the earth-current was manifested by the earth's magnetism, the connection of which with the electricity of the earth attracted attention from the very beginning, when disturbances made themselves observable. To demonstrate with perfect precision the coincidence of the two phenomena it was necessary to take for the purpose of comparison not a single earth-magnetic element, but the earth's total magnetism. The earth's electricity and the earth's magnetism showed, moreover, in their regular daily course, their affinity, by the simultaneity with which their disturbances occurred. This simultaneity was so precise that in one case the distance between Berlin and Wilhelmshaven could be determined from the time when the disturbance of the earth's current made itself felt in Berlin and the time when the magnetic disturbance occurred in Wilhelmshaven. This simultaneity of disturbances at distant points of the earth pointed to a cosmical cause. Thus in August last year, at the very time when in Paris the emergence of an altogether unusual solar protuberance was observed, a magnetic disturbance was registered in Petersburg, and a disturbance of the earth's current in Berlin. The earth's current and the earth's magnetism showed further in common the periods of eleven years which coincided with those of the solar spots. In respect of the earth's current, this period could not indeed be demonstrated to a certainty, seeing that the regular observations made respecting it were yet of too recent date; but the regular course of the oscillations warranted the conclusion of a like period being drawn. A period of from two to five days in which the earth's current and the earth's magnetism showed in their oscillations alternately larger and smaller amplitudes had, in addition, been detected, although the explanation of the phenomenon was not yet forthcoming. With reference to the question which phenomenon was the primary, the earth's current or the earth's magnetism, opposite views were entertained. The earth's electricity was assuredly not strong enough to magnetise the body of the earth; but, on the other hand, against the assumption that the earth's currents were induced by the oscillations of the earth's magnetism an objection might be raised, namely, that in such a case the earth's currents would have to be proportional to the velocities of the oscillations of the earth's magnetism, and not to the oscillations themselves. This question can only be decided by further observations and by experiment. In a wide circle out of telegraph circuits the induction effects of the earth's magnetism might be studied and compared with the earth's currents. The speaker discussed the different theories of the earth's electricity set forth by Faraday, De la Rive, Lamont, Edlund, and the Brothers William and Werner Siemens, without declaring himself decidedly in favour of any of them. In conclusion he drew attention to the series of different jerks which showed themselves in the self-registering curve of the earth's currents on the occasion of every thunderstorm. A jerk of this description on the part of the pointer seemed to correspond with each lightning-flash.

BOOKS AND PAMPHLETS RECEIVED

"Memoirs of the Geological Survey of India": "Palæontologia Indica," Ser. xiii. "Salt-Range Fossils, (i.) Productive-Limestone Fossils; (5) Bryozoa-Annelida-Echinodermata" (with Plates lxxxvii.-xcvi., by W. Waagen (Trübner).—"Quarterly Journal of the Microscopical Society," April (Churchill).—"Malvern, its Ferns, &c.," by G. E. Mackie (*Malvern Advertiser*).—"Sacred Books of the East," edited by F. Max Müller, vol. xxvi. "Satapatha Brâhmana," part 2, books iii. and iv., by J. Eggeling (Clarendon Press); vols. xxvii., xxviii., "The Li-Ki," by J. Legge.—"Annales de l'Observatoire de Moscou," vol. i. part 1, 1886 (Lang, Moscou).—"British Fungi," vol. i., by Rev. J. Stevenson (Blackwood).—The Naturalist's Diary," by C. Roberts (Sonnenschein).

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