THURSDAY, APRIL 1, 1880

FOSSIL ECHINODERMS

Handbuch der Palæontologie. Unter Mitwirkung von W. Ph. Schimper, Professor an der Universität zu Strassburg, herausgegeben von Karl A. Zittel, Professor an der Universität zu München. I. Band, iii. Lieferung. Mit 195 Original-Holzschnitten. (München: R. Oldenbourg, 1879.)

MORE than three years ago a notice appeared in these columns (vol. xiv. p. 445) of the first Part of a new treatise on Palæontology by Professors Zittel and Schimper. Of the first volume, that which is devoted to Palæozoology, and is from the pen of Prof. Zittel, three Parts have now been published. The last one, which deals with the fossil echinoderms, fully justifies the great expectations to which the first gave rise, both text and illustrations being of a very high order of excellence.

It commences somewhat abruptly in the middle of a sentence belonging to the introductory chapter on the sub-kingdom generally, the earlier pages of which appeared at the end of Part 2. At the end of the volume, in like manner, there are four pages which contain the first portion of the chapter on the Vermes.

Like most Continental writers, Prof. Zittel divides the Echinoderms into four classes only, viz., Crinoids, Starfishes, Urchins, and Holothurians. The first class is a large one, including the Cystids and Blastoids, as well as the true Crinoids, or *Eucrinoidea*, as Zittel calls them; and very nearly half the book is devoted to it, while the Urchins take up the greater part of the remainder.

Each class is treated separately as regards its general anatomy, terminology, classification, and distribution, both in space and in time. Besides the numerous references scattered through the text, a valuable bibliographical list is appended at the commencement of every section but that on the Holothurians, to which, for obvious reasons, only one page is devoted. In the sections on the Urchins and the Crinoids the results of the *Challenger* Expedition (so far as published) are fully considered, and attention is drawn to the analogy between the recent *Comatulæ* and the palæozoic Crinoids in the very limited geographical distribution of individual specific forms, and in some cases even of genera.

The chapter on the general anatomy of the Crinoids is fairly complete, except as regards the blood-vascular system, and exceedingly accurate on the whole, though we must take exception to the passage on p. 329, in which it is stated that *all* (*sämmtliche*) living Crinoids have a central mouth and an excentric anal opening. Nearly forty years ago Müller described several *Comatulæ* with an excentric mouth and a central anal tube. These have been since grouped into the genus *Actinometra*, which includes quite one-third of the species of recent *Comatulæ*. Almost the only recent work on the Crinoids to which no reference is made is Ludwig's singular suggestion that the genital plates of the Urchins and Asterids are homologous, not with the genitals of the Ophiurids and the basals of the Crinoids, as hitherto supposed, but with the *oral* plates of both these groups. Probably, however, this is only because Ludwig's paper was published too late to receive the notice which it deserved. To this same category of oral plates Dr. Zittel refers the remarkable "Consolidations-Apparat" in the calyx of *Cupressocrinus* and the corresponding plates which lie above and alternate with the radials in *Cyathocrinus* and allied genera. This appears to us to be a very probable explanation of the homologies of these plates; and we wonder that the so-called "deltoid pieces" of the Blastoids are not regarded by Prof. Zittel in the same light, for they occupy precisely the same position between the radials and the central mouth as the oral plates of *Cyathocrinus*.

Schültze's views as to the subtegminal mouth of the palæozoic Crinoids are of course fully adopted, but the author does not altogether follow Wachsmuth's arrangement of the group according to the three principal plans upon which the vault is constructed; for the vault of the *Taxocrinidæ* is described as resembling that of the *Cyathocrinidæ*, whereas, according to Wachsmuth, the structure of the vault is essentially different in the two families. Prof. Zittel also accepts Schultze's views as to the position of the boundary line between the plates of the arms and those of the calyx; and he brings forward a strong piece of evidence in their favour, namely, that according to Dr. Carpenter's observations the first radials of *Comatula* correspond essentially in their origin and mode of growth with the basals and orals, appearing as plate-like films from the first, and that they therefore belong to the calyx. On the other hand, according to Sir Wyville Thomson, the second and third radials do not, like the first, begin as expanded cribriform films, but first appear as horseshoe-shaped spicula or imperfect rings; and Dr Carpenter has shown that the origin and development of the arm-joints is of essentially the same character. As in the Urchins and Starfishes, therefore, the calyx normally contains but two rows of plates, viz., the radial series above, and below them the inter-radially situated basals; though in some Crinoids there is a third series of plates, the underbasals, which occupy a radial position between the true basals and the top stem-joint.

The author's descriptions of the arms and their appendages do not seem to us to be always quite consistent. In the *Comatulæ* with ramifying arms all the branches are equivalent. Each of the ten primary arms may fork and give rise to two equal secondaries. Each of these again may bear two equal tertiary arms, and so on, the successive divisions forking altogether perhaps five or six times, and the two divisions borne by any axillary being equal to one another. In some of the stalked Crinoids, however, this regular forking ceases with the second axillary, which bears, not two equal tertiary arms, but a smaller one that remains undivided, and a larger one that continues the line of the secondary arm and ends in an axillary joint. This also bears two unequal arm-divisions, and the same mode of branching is continued on each successive axillary. These smaller lateral branches, which may always be on the same side of the main arm trunk, or may alternate on opposite sides, are termed "Nebenäste" by Zittel, who rightly states that they appear when there is no forking. There is therefore a little inconsistency in his describing the arms of *Cyathocrinus* and *Euspirocrinus* as many times or repeatedly forked, while in the diagnosis of the family the arms are described as having "Nebenäste," and the figures of both genera show that this is the mode of division above the secondary axillaries.

Despite Lütken's arguments to the contrary, Müller's division of the true Crinoids into *Tesselata*, *Articulata*, and *Costata* is adopted with but a few slight modifications, on the ground that it furnishes well-defined natural groups.

The grouping of the families in each sub-order is in great part a new one, though based to some extent on the works of Roemer, Angelin, and Wachsmuth. The sub-order *Tesselata* includes twenty-six families which are arranged in five sections, chiefly according to the structure of the vault, and the relations of the oral plates. Seven of these families are new, while some of those which date from an earlier period have been slightly modified in their extent. The *Articulata* fall into seven families, of which two are new, viz., the *Eugeniacrinidæ* and *Plicatocrinidæ*, while the limits of Roemer's family, *Holopodidæ*, are slightly altered. The recent *Hyocrinus*, which is referred by Sir Wyville Thomson to the *Apiocrinidæ*, is regarded by Prof. Zittel as most probably identical with *Plicatocrinus*, and the well-known genus *Rhizocrinus* of M. Sars is identified with the very imperfectly described *Conocrinus* of d'Orbigny, the latter name being resuscitated on grounds of priority, while *Rhizocrinus* is reduced to the rank of a synonym. We venture to think that this is somewhat inexpedient, for Sars's name is now universally employed, and there can be no possible doubt as to the characters of the type to which he gave it; whereas Zittel himself admits that d'Orbigny's diagnosis of *Conocrinus* is incomplete and even partially incorrect.

Among the *Comatulidæ* the fossil *Solanocrinus* with external basals, is retained as a type distinct from that of the recent and fossil *Antedons* which lack this peculiarity, although Schlüter, like others before him, has recently attempted to merge *Solanocrinus* in *Antedon*. There is one portion of the diagnosis of this type in which clearness has been too much sacrificed to brevity. It is as follows. "Dorsal organ (heart) round, without radial pits." The meaning which these words are intended to convey is that the centrodorsal piece has a round central cavity in which the chambered organ (the so-called heart) was lodged, and that there are no radial pits around its opening. In recent *Comatulæ*, however, the presence or absence of these pits is far too irregular within specific limits to be of any systematic value, while Quenstedt has found them to be sometimes present in *Solanocrinus*, although, according to Zittel, they should be absent.

The Cystids and Blastoids are classified according to the systems proposed by Müller and Roemer respectively. *Agelacrinus* is referred to the Cystids, and not made the type of a new class as is sometimes done in this country; while *Codonaster* is transferred from the Blastoids to the Cystids, in accordance with the views of the late Mr. Billings. *Stephanocrinus*, on the other hand, placed by Roemer among the Cystids, is here regarded as a Blastoid.

The Starfishes are all grouped together into one class, the *Asteroidea*, which contains the two orders *Ophiuridæ* and *Stelleridæ*. The palæozoic forms of the latter, with alternating ambulacral plates, are in accordance with Bronn's classification, separated as *Encrinasteriæ* from the true Stellerids or *Asteriæ veræ*. These are classified chiefly according to the system of Müller and Troschel, which has been the basis of almost all palæontological work on the group, though the author admits that it requires much revision as regards the recent forms.

The classification of the *Echinoidea*, however, contains some new features. The name *Echinocystites*, proposed by Wyville Thomson in 1864 for a remarkable palæozoic form which he regarded as intermediate between Cystids and Echinids, is discarded in favour of *Cystocidaris*, Zittel, on the ground that Hall used the same name three years later for a true Cystid from the Upper Silurian of Wisconsin. *Cystocidaris* is made the type of a new order which, together with the *Bothriocidaridæ* and the *Perischoëchinidæ*, constitute the sub-class *Palechinoidea*, Zittel. Lovén's arrangement of the *Perischoëchinidæ* is the one adopted, except that the family name *Palaëchinidæ*, M'Coy, gives way to *Melonitidæ*, Zittel. The other Urchins constitute the sub-class *Euechinoidea*, Bronn, the regular forms being grouped into four families, viz., the *Cidaridæ*, *Salenidæ*, *Echinothuridæ*, and *Glyphostomata*, this last including the sub-families *Diadematidæ* and *Echinidæ*. In view of the observations of Lovén and Ludwig on the mobility of the plates of the hinder interambulacrum in the *Spatangidæ* and *Holasteridæ*, the author does not regard the *Echinothuridæ* as so clearly related to the *Perischoëchinidæ* as has been supposed by some writers, but considers the characters of their ambulacral and interambulacral areas to indicate the *Diadematidæ* as their nearest allies.

The primary classification adopted for the irregular Urchins is that of de Loriol, which depends upon the presence or absence of a dentary apparatus. Each of his sub-orders, *Gnathostomata* and *Atelostomata* is made to include three families, those of the first being the *Echinoconidæ*, d'Orb., the *Conoclypeidæ*, Zitt., and the *Clypeastridæ*, Ag., while in the *Atelostomata* are included the *Cassidulidæ*, Ag., *Holasteridæ*, de Loriol, and the *Spatangidæ*, Ag., as arranged by de Loriol.

The illustrative woodcuts, like those in the earlier Parts of the "Handbook," are remarkably clear and effective, though in a few cases they might, with advantage, have been a trifle larger. Many of them are new and original, while others, especially in the Crinoid section, are copied from the works of the American palæontologists and from Angelin's "Iconographia." The figures of Echini in the latter half are mostly of exceeding merit, while many beautiful analytical diagrams are reproduced from Lovén's "Echinoid Studies."

This Part of the "Handbook," which seems to us fully to keep up the high character of its predecessors, concludes with p. 564 of the first volume. The chapters on the *Vermes*, *Mollusca*, *Arthropoda*, and *Vertebrata* have yet to appear, and will do so, we trust, at no very distant date.

MEDICINE PAST AND PRESENT

Pharmacology and Therapeutics; or, Medicine Past and Present. By Dr. Lauder Brunton, M.D., &c. (London: Macmillan and Co., 1880.)

DURING the last two or three decades, and especially during the last decade, a change has been going on in therapeutics, that is, in the doctrines of remedies for disease, of so fundamental a character, that it may with reason be called revolutionary. The change, however, is one which so far is but little "understanded of the people," is one, in fact, of which they are almost entirely ignorant. If the question were put to the several members of either House of Parliament, What reasons determine a doctor to give such and such a drug for such and such a disease, and what led to the drug being first used for such a purpose? the answer would in all but a few exceptional cases run somewhat as follows:—"A doctor gives a particular drug in a particular case, because he knows from the experience, either of himself or of others, in similar cases, that it is more likely to do good than anything else (or than nothing at all). As to the first use of a drug, that I believe is in most cases lost in obscurity; and I am told that the use of more recent drugs has either been stolen from some village crony or borrowed from some savage, or suggested by the instinctive actions of some domestic or wild animal. I understand that some doctors are fond of 'making experiments,' *i.e.*, of giving new drugs in this or that disease to see if they can cure it. I don't know what reasons lead them in a particular case to experiment with a particular drug, but I suppose they have some reasons. I dare say accident sometimes suggests a possible cure, and I have a sort of an idea that very often one remedy after another is tried at random, in the hope that one of them at least may prove beneficial." To judge from the speeches and writings put forth at the time of the framing of the Vivisection Act, neither the legislators themselves nor even the more intelligent and educated doctrinaires who pressed for legislation, to say nothing of the common ignorant agitators, had any conception that the use of many popular and successful remedies was the result of the recent labours of able and zealous men who had devoted themselves to the *scientific* investigation of the action of drugs and other agents on the animal economy.

In former times undoubtedly therapeutics were to a large extent purely empirical and indeed traditional. But, in spite of the ignorance of the ruling classes and public in general, in spite of the obstructions caused by a clumsy legislation, a great change is taking place. It can no longer be said, as was once said, that a doctor is "one who puts into a body, of whose actions and powers he knows little, a substance of whose actions and powers he knows less." While physiologists in general have been gaining fuller and fuller insight into the mysterious working of the living economy, a number of men have for years past been investigating, with the help of the most exact methods and appropriate instruments, and with all the light afforded by modern chemistry and physics, the more special problems, still, however, physiological in essence, concerning the nature of the changes induced in living bodies by the substances known as drugs or poisons. Already even many precious hints as to therapeutic utility have thus been gained; already many previously obscure bodies have thus become popular remedies, and in a double sense "in everybody's mouth." Sufficient has been done to show that for the new remedies of the future we shall have to apply, not to some wandering gipsy or sagacious dog, but to the experimental pharmacologists, whose duty it will be to subject to a rigorous inquiry every newly-discovered chemical body or natural product, with the view of estimating its therapeutic promise.

It cannot of course be said that the science of pharmacology or of therapeutics is at present ripe and complete; the knowledge is as yet in the early fermentative stage; a great deal of the work done is of a tentative, preparatory kind; and the results cannot as yet be fairly judged. But to those who know what has been done and what is being done, the importance and greatness of the change in therapeutics which is thereby being inaugurated, seems almost incapable of exaggeration; they look forward with confidence to a future, and possibly not far distant, mastery over disease, compared with which the practice of to-day will seem hardly more than blind stumbling.

Distinguished among English workers in this line of inquiry is Dr. T. Lauder Brunton; and in the present little volume, which consists of the Goulstonian Lectures, delivered before the Royal College of Physicians in the spring of 1877, he lays before his readers a sketch of therapeutics past and present, with the view of showing "how the progress of therapeutics is aided by an exact knowledge of the action of drugs obtained by experiment."

Though addressed primarily to the medical profession, the work is written in a graceful popular style, and might be read with pleasure and profit by laymen. The first few chapters are occupied with a survey of the progress of medicine in the past, and though agreeably written, and suitable for the purpose intended, viz., as introductory to an understanding of the true method of therapeutic research, are somewhat slight and sketchy. In one or two points we should feel inclined perhaps to dispute Dr. Brunton's criticisms and judgments. The rest of the work is taken up with a more or less detailed and expository account of the mode of action of certain drugs, such as strychnia, urare, casca, digitalis, &c., the methods of investigation being described with characteristic clearness and the therapeutic indications of the results being judiciously discussed. The book is one which may be studied with benefit by all medical men, and those not belonging to the profession who desire to have an insight into some of the tendencies of modern medicine will find it a trustworthy and intelligent guide.

THE COMSTOCK LODE

The Comstock Lode; its Formation and History. By John A. Church. 4to. (New York: John Wiley and Sons, 1879.)

THE great interest attaching to the mines of the Comstock lode has led to their being carefully and minutely studied by competent observers at different times. Prominent among these is the original investigation of Baron von Richtofen, published at San Francisco in 1866, who, bringing to the task an unusual knowledge of the class of volcanic rocks in which the lode is inclosed, was enabled to sketch out the broad features of the subject in so masterly a manner as to leave little more for later explorers than the filling in of details. These were supplied in very full measure in the magnificent volume of Clarence King and James D. Hague, forming part of the United States Survey of the 40th parallel, copies of which, by the enlightened liberality of the United States Government were freely supplied to the geologists and engineers of other countries. The rapid increase of the mines in depth, from 500 to 2,000 feet and upwards during the last few years, has, however, to some extent superseded, or rather rendered a supplement necessary to the earlier accounts, and this is supplied by the volume under consideration. The Comstock lode was discovered in 1859 by some gold miner in a pit sunk for a water-hole, and "milling," or reduction of the ore, commenced in the same year, but during the first twelve months the amount of precious metals produced did not exceed 20,000*l*. in value. Since then it has become the largest gold and silver producing locality in the world, the yield during the nineteen years of its history having been, according to different estimates, from 60,000,000*l*. to 70,000,000*l*. in gold and silver. The ore is of two kinds, poor or low grade, averaging in yield from 4*l*. to 7*l*. per ton, and rich, worth from 8*l*. to 22*l*. per ton. These richer ores occur in large bodies or "bonanzas" recurring at irregular intervals both along the course of the lode and in depth. One of the most remarkable, that of the Consolidated Virginia and California mine, discovered in 1873, at 1,300 feet below the surface, measuring 500 feet in depth, 700 feet in length, and 90 feet in thickness, yielded in six years over a million tons of ore, averaging 19*l*. per ton value. The metal or bullion produced is worth from 9*s*. to 10*s*. per ounce, representing a composition of about 94 per cent. silver and 6 per cent. gold. The author discusses the various conditions under which these great masses may have been introduced into the lode, distinguishing the periods of eruption of the different volcanic rocks forming the walls from the so-called "chemical periods" when the strata of diorite, andesite, and propylite were attacked by water containing silica and dissolved or disintegrated, the hollows formed being filled up by masses of quartz without metallic minerals of value. Subsequently a great eruption of trachyte took place, accompanied by movements of the walls of the lode, opening fissures more steeply inclined than those of the first period. These in the "second chemical period" were filled by quartz in the same manner as before, but this time accompanied by gold- and silver-bearing minerals, a trace of this action being still recognisable in the hot waters of the Steamboat Springs about twelve miles distant, which, as shown by Mr. J. A. Phillips and others, deposit a siliceous sinter containing at times cinnabar and metallic gold. On an extensive study of the various phenomena presented by the distribution of the ore bodies both in length and depth, the author, like a true miner, takes a hopeful view of the future, and considers that the prospect of finding a second and lower zone of ore-production within attainable depths is very good. The spirit with which the explorations are followed is best shown by the statement that some half-dozen new vertical shafts are now sinking to cut the lode at depths of 2,500 feet and upwards, one of them being expected to attain a perpendicular depth of 4,500 feet.

Of almost equal interest to the mineral wealth of the Comstock lode are the peculiar heat phenomena observed in the workings, which are very fully described by the author. The air in the lower levels and deep shafts has in places temperatures of from 110° to 120° Fah., while the rock and the water pumped from some of the flooded workings at times attains 150° and 155°. In one instance 158° was observed in the water of a level at 1,800 feet in depth. The author puts forward the hypothesis that these very high temperatures are due to the kaolinisation of the rock, a large amount of heat being supposed to be evolved by the fixation of water in the production of the great masses of clay which characterise the rocks in the immediate vicinity of the lode, and in his own words: "This theory is advanced with confidence in spite of the disadvantage that no estimate can be made of the specific quantity of heat which is produced by the change mentioned." Under these circumstances it seems scarcely necessary to discuss the point, more especially as it has been pointed out by Mr. Phillips, in a paper recently read before the Geological Society, that the application of the only available numerical test, namely, comparison of the amount of alkalies in the water pumped from the mines with that contained in the undecomposed rock as a measure of the amount of change, gives such impossible results as to prevent acceptance of the hypothesis in the absence of more positive data. The fact of the boiling springs at Steamboat Springs, twelve miles distant, being diminished considerably in their flow with the increased depth of the mines, while the mine water has become sensibly hotter, would appear to point [to a natural hypothesis of common origin in the last or solfataric stage of the phenomena that produced the lode. The volume is illustrated by plans and sections taken from the working surveys of the mines of very great interest and value.

H. B.

OUR BOOK SHELF

Micrometrical Measurements of Double Stars made at the Cincinnati Observatory in 1878 *and* 1879, *under the Direction of Ormond Stone, M.A.* (Published by Authority of the Board of Directors of the University, Cincinnati, 1879.)

THE measurement of position and distances of double stars is perhaps one of the most common researches for which a telescope is used, perhaps for the reason that no elaborate apparatus is necessary, and also that almost every one thinks that a double star can be measured without much previous training of the eye. Owing to the high latitudes of most of the observatories engaged on the subject, the stars south of the equator are in a great measure neglected compared with those north of it, and in the volume before us we are glad to see that the southern stars from the equator to – 30° have received the greatest attention, some having been measured on twenty or thirty different occasions. Altogether there are 2,250 different observations of the 1,054 double stars appearing in the catalogue; of these 560 are from Struve's catalogue, 171 discovered by the Herschels, 162 by Burnham, and 85 new discoveries. The results appear to have been corrected with great care and the method of correcting observations for errors due to the position of stars relative to the horizon is set forth at considerable length. We notice that all the observations are made with eyes in such a position that a line joining them would be either parallel or normal to the line joining the stars, a point that cannot be too much impressed on observers of double stars, since the error often occasioned by neglect of this precaution is surprisingly large. We believe the parellel position to be subject to the last error.

It seems to be rather a waste of printing to set forth five columns containing position-circle readings and assumed zeros, together with the actual readings of distance, the resulting positions and distances being all that is wanted. The volume is, however, a valuable addition to double star measurements.

The Ophiuridæ and Astrophytidæ of the "Challenger" Expedition. By Theodore Lyman. Part 2, Bull. Mus. Comp. Zool. Vol. vi., No. 2. (Cambridge, Mass.)

THIS is the second part of the preliminary description of the Ophiuridæ and Astrophytidæ dredged by the *Challenger*. Prof. Lyman issued the first part of the Prodromus some time ago. The Prodromus is of course merely an abridgment. Prof. Lyman's full account of the Ophiuridæ will appear in the large work on the *Challenger* Expedition. To the present part is added an index of species contained in the two parts, together with all others described elsewhere by Prof. Lyman. The whole forms a list of the greater portion of deep-sea Ophiurans and Astrophytons known. The list comprises fifty-three genera and about two hundred and twenty-three species. In the present part two new genera and sixty-three new species are described. Prof. Lyman considers that the Ophiuran which was recently described by Prof. Martin Duncan under the name of *Ophiolepis mirabilis* (*Linn. Soc. Journ. Zool.*, xiv. 460, 479), is a true Ophiopholis, lacking none of its characters, and standing quite near the typical *O. aculeata*. Priority is given in all cases by Prof. Lyman to specimens dredged by the *Challenger* over those obtained by the later series of dredgings carried out by the United States Government under Mr. Alexander Agassiz. A similar priority has been generously given by Mr. Agassiz to the *Challenger* Echinoidea, and Count de Pourtales has shown similar consideration in the matter of the corals. Owing to the delay in the publication of the *Challenger* results, the American naturalists could easily have secured priority for their collections, had they thought fit to do so. They have in their hands almost all the forms of any importance which the *Challenger* obtained, for by their continued operations they have dredged them nearly all on the United States coast and around the West Indies. The thanks of English naturalists is certainly due to the American zoologists for their courtesy in this matter.

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 ensure the appearance even of communications containing interesting and novel facts.*]

The Density of Chlorine

THE article on the density of chlorine, bromine, and iodine at high temperatures which appeared in NATURE, vol. xxi. p. 461, places before your readers in the clearest manner the present condition of this important question. The conclusion hinted at in the closing sentences of the article, viz. that these gases are under certain circumstances decomposed, is however scarcely warranted. Dr. Armstrong thinks that these substances may be more liable to decomposition when in a nascent state. It is generally supposed that in this condition the atoms of a substance are separate, having as yet had no opportunity of selecting a mate for their further career; if therefore we could observe the density of a gas in the nascent state, we should find that it was only half the theoretical density. In the case of chlorine evolved from platinum chloride at a high temperature we may readily imagine the emerging atom, set in rapid movement by the great heat, to be unable at any time to join with another to form a molecule; we should thus have the nascent state maintained, if I may be allowed the expression, as long as the temperature was high enough. It is further possible that there may be a wide interval between the temperature at which chlorine gas is molecular and that at which it is entirely atomic, and that in this interval a certain proportion of the gas varying with the temperature is resolved into its atoms, the rest remaining molecular. The gas would then have a density intermediate between the theoretical density 2·45 and its half, 1·23, a density in fact corresponding with that obtained in Meyer's experiments.

It may be urged that this attempt at an explanation, necessitating as it does a density varying with the temperature, is incompatible with the facts, since Meyer obtained a uniform density of about 1·6 in all his experiments. It must however be remembered that these observations cannot lay claim to great accuracy, and that the recurrence in several experiments of the same observed density may often be ascribed to chance.

Of this we have an excellent example in the experiments recently recorded in the *Proceedings* of the Royal Society by Prof. Dewar and Mr. Scott. The densities required were those of the vapours of potassium and sodium. In a first series of experiments which were made in an iron vessel the mean density of potassium vapour (referred to hydrogen) was found to be 40·8, that of sodium vapour 25·33, whence it was naturally inferred that those vapours were normal in character. In a second series of experiments, in which a platinum vessel was used, the densities 21 and 13 were found for potassium and sodium vapours respectively; from this it was with equal reason inferred that these metallic vapours were atomic, and resembled that of mercury. Unless platinum has a special dissociating effect on the molecules it must be admitted that in the one series or the other (since they were both made at similar temperatures) the concordance of the results was due to chance.

That the density of chlorine is really subject to gradual variation as the temperature increases, is rendered very probable by the results obtained by Meyer with iodine; the table of these results given in the article referred to (NATURE, vol. xxi. p. 461) shows clearly that the density of iodine decreases gradually, and there would seem to be no reason whatever for the assumption that it is complete at about 1,500° C.

I fear that I trespass much on your space in thus trying to point out that the otherwise inexplicable density 1·6 most probably represents only a stage on the road to the complete dissociation of the molecules, a stage more readily reached by a nascent gas than by one in which the molecules have to be dissociated; the importance of the subject must, however, be my excuse.

Clifton College, Bristol, March 21 FRED. D. BROWN

The Annual Variation of the Barometer in India

IT has been pointed out by Mr. Archibald, in NATURE (vol. xx. p. 54), that the late Mr. J. A. Broun, F.R.S., was probably mistaken in supposing (see vol. xix. p. 6) that there is no direct causal connection between the annual variations of temperature and atmospheric pressure in India. Mr. Broun appears to have adopted this opinion because, at all places in India where the annual oscillations of temperature and pressure are considerable, their turning points are not the same. The highest pressure usually occurs about the middle of December, and the lowest at the end of June, while the lowest temperature is reached during the first ten days of January, and the highest in the latter half of May.

Having been employed a short time ago in calculating the constants of Bessel's formulæ for the annual variations of temperature and pressure at Allahabad, I noticed that the first term of the pressure formula, which includes nine-tenths of the total variation, reaches its maximum almost exactly at the time of lowest annual temperature. The value of this term at the middle of January is ·271" sin 101° 32′, and its maximum therefore falls about $11\frac{1}{2}$ days before the middle of January, that is on January 4th or 5th. The same term of Bessel's formula for Benares is represented by ·279" sin 102° 34′, and for Roorkee by ·258" sin 103° 12′. The maximum pressure at these two stations therefore falls about the 3rd of January, if we take the oscillation of annual period alone. The first periodic term of the formula for the annual variation of pressure at Bombay is given by Mr. C. Chambers ("Meteorology of the Bombay Presidency," p. 16) as ·1405" sin 87° 2", the angle being counted from the 3rd of January at the rate of 30° for a month. This throws the maximum forward to the 5th January.

The pressure oscillation of full annual period may be supposed to represent the most important part of the effect of the annual variation of temperature, freed from all minor inequalities due to changes of wind and other causes. The close coincidence of the time at which this pressure oscillation attains its maximum with the time of the temperature minimum at the earth's surface, and presumably at great elevations also, supports the generally-received conclusion that the pressure variation is an effect of the annual inequality of temperature.

Having thus good *primâ facie* evidence for believing that by far the greater part of the annual variation of pressure may be explained on simple hydrostatic principles, I thought it desirable to test this conclusion by Mr. Archibald's method of substraction, making use of somewhat fuller data than were at his disposal when he wrote the letter above referred to. The observations I have adopted are those of Roorkee, 887 feet above the sea-level; Dehra, 2,232 feet; Chakráta, 7,052 feet, and Leh, 11,503 feet elevation. The first three stations lie within a few miles of each other, their latitudes being 29° 52′, 30° 20′ and 30° 40′ N. respectively. Leh is at a considerable distance to the north, in latitude 34° 10′ N. The four stations are situated nearly on the same meridian, the difference of longitude between the most westerly and the most easterly amounting to less than half a degree.

The mean annual values of temperature and pressure at these four places are the following:—

Station.		Temperature.		Pressure.
Roorkee	(17 years)	74·9° F.	(12 years)	28·889 inches.
Dehra	(12 ,,)	70·6° F.	(12 ,,)	27·567 ,,
Chakráta	(10-11 ,,)	56·3° F.	(4 ,,)	23·225 ,,
Leh	(2-7 ,,)	39·3° F.	(4-6 ,,)	19·659 ,,

With the exception of the temperature figures for the winter months at Leh, the data are all for sufficiently long periods to be taken as fairly representing normal values of temperature and pressure. From these the average temperatures and barometric weights of three successive strata of air have been calculated, and the results, together with the variations in each month from the annual average values, are given in the next table.

Strata between	Roorkee and Dehra.		Dehra and Chakráta.		Chakráta and Leh.		Roorkee and Leh.	
Vertical thickness.	1,345 feet.		4,820 Feet.		4.451 Feet.		10,616 Feet.	
Annual means.	Tem.	Bar. Weight	Tem.	Bar. Weight	Tem.	Bar. Weight	Tem.	Bar. Weight
	72·8°	1·322″	63·4°	4·342″	47·8°	3·566″	57·1°	9·230″
Variations in January	−17·0	+·067	−15·2	+·129	−17·2	+·092	−20·0	+·289
February	−13·2	+·044	−12·6	+·123	−14·9	+·082	−15·5	+·249
March	− 4·6	+·013	− 5·3	+.050	− 7·5	+·034	− 6·7	+·097
April	+ 6·0	−·018	+ 3·3	−·022	+ 2·1	+·017	+ 3·7	−·022
May	+12·3	−·041	+10·0	−·073	+ 7·5	−·040	+10·2	−·152
June	+14·5	−·050	+13·0	−·138	+13·0	−·074	+15·0	−·262
July	+ 9·5	−·040	+ 8·9	−·108	+14·7	−·070	+15·7	−·217
August	+ 8·7	−·031	+ 8·1	−·097	+13·0	−·048	+13·7	−·176
September	+ 7·2	−·021	+ 6 7	−·075	+ 8·6	−·031	+ 9·2	−·126
October	+ 0·8	−·001	+ 0·6	+·003	0·0	+·004	+ 0·1	+·007
November	− 9·1	+·027	− 6·1	+·085	− 6·4	+·005	− 9·3	+·117
December	−16·0	+·049	−12·1	+·125	−12·4	+·027	−16·6	+·201

From these figures it is evident that when the temperature is above the average the pressure is below it, and *vice versâ*. The only exceptions to this rule, which applies to each separate stratum of air as well as to the whole thickness of 11,616 feet, occur in the months of April and October, when the variations of the barometric pressure from the mean of the year are within the limits of the probable error of the observations.

The variations of the density of each layer of the atmosphere are also very nearly *proportional* to the temperature variations, as they would be if the air expanded and contracted *freely* with changes of temperature. Thus the mean decrease of density for one degree of rise in temperature between Roorkee and Chakráta is ·00235. At the mean temperature of these two stations, 65·6°, the co-efficient of expansion per degree Fahr. is ·0019. The observed variation of density is thus slightly greater than that which would be caused by change of temperature alone, but the difference may be completely accounted for by the larger proportion of aqueous vapour in the air in the hot than in the cold months.

Taking the mean pressure of the lowest stratum of air (that between Roorkee and Dehra) to be the arithmetical mean of the pressures observed at the top and bottom, and supposing the mean tension of vapour in it to be similarly obtained, we may calculate the ratio of its densities in the hottest and coldest months by the usual formula:—

$$\frac{d}{d'} = \frac{P - \frac{3}{8}f}{P' - \frac{3}{8}f'} \cdot \frac{460 + t'}{460 + t}$$

With the data P = 28·428, P′ = 27·982, f = ·301, f_2 = ·695, and the temperatures given in the preceding table, the ratio of the density in June to that in January comes out ·921, while the ratio of the barometric weights is ·916. A similar calculation for the stratum between Dehra and Chakráta gives the ratio of the densities in the hottest and coldest months equal to ·933, that of the barometric weights being ·943.

It follows from these results that the annual variation of the barometer over the plains of India and up to a considerable elevation in the Himalayas may be explained by simple hydrostatic principles. A moment's consideration will also show that the double oscillation observed at the hill stations, which is somewhat puzzling at first sight, may be explained in the same way, without bringing in any hypothetical saturated antimonsoon current.

It is the combination of this, at first sight, anomalous variation in the upper regions of the atmosphere, with the variations due to simple changes of density below, that gives rise to those peculiarities of the annual change of pressure in India which led Mr. Brown to give the weight of his great name in meteorology to an opinion that is clearly erroneous.

Allahabad, 18th February S. A. Hill

Gunnery Experiments

I have read with interest the leading article on Gunnery Experiments in Nature, vol. xxi. p. 437. The question seems to me to be one not alone of build, but—and perhaps principally—of muzzle-loading *versus* breech-loading, and of rifling for or without studs. The Admiralty seem to think so, as appears, I presume, from their resolution to adopt breech-loading for the turrets of the *Colossus*. With breech-loading double loading is an impossibility, as well as jamming of studs, since there are none, at least in the first artilleries of Europe. I dare say Sir W. Palisser's *build* is better than any other known in England; but then with it the best guns would be breech-loaders.

Contrary to the grand practice of Europe, England has hitherto, with characteristic tenacity, retained muzzle-loading for *great* guns. Now she will, I apprehend, have to reform and to pay enormous sums as a penalty, besides enduring the very inconvenient feeling of temporary inferiority in a means of great importance. X.

The Hague, March 15

A Museum Conference

I deprecate as strongly, though not so violently, as "Academicus," an association to talk about museums, but I cannot agree with his reasoning on the subject of museums and their curators. I have had twenty years' daily experience of museum work, and at the risk of being dubbed a pretentious curator I can assert I have brought an average intelligence to bear on my work. With a certain amount of sympathy for the strictures of "Academicus" on the multiplication of conferences, I am yet free to assert that in no department of public work might and could greater public advantage result from close association of officials than from a union of museum curators. A provincial curator must often be oppressed with the conviction that he is spending weeks over a task which is already, in some other locality, done to his hands, and he must likewise know that the labour he is in other instances performing, and the objects he is manipulating would be sufficient for the wants of a dozen institutions like his own. He knows that he wants what others have, and that from his abundance others might be filled. Then again, in a general museum, the presiding officer, to be thoroughly efficient, should be master of the circle of the sciences, and have a familiar acquaintance with all arts and art. But science is all-embracing, art is long, and the arts of to-day are obsolete to-morrow. I say in contradiction of "Academicus" that museum officials only know their business when they know their ignorance, and that proper salaries are not their only or chief want. In a scientific sense the best men would be the worst museum curators, and were the municipalities of Great Britain each to offer the salary of a cabinet minister for the services of a museum superintendent, I do not think the institutions would thereby at once be so much revolutionised as "Academicus" thinks.

I am happy to be able to announce that the Council of the

Society of Arts have resolved to give the projected conference their most cordial support, should an executive committee be formed. The Council have promised to accommodate such a conference in their rooms, and to undertake the publication of Proceedings, &c. Here therefore is a nucleus around which a practical project may well form itself, and following on this step I hope soon another may be taken. Allow me through your columns to thank my various correspondents for their support and suggestions. JAMES PATON

Glasgow, March 29

IN your last number "Academicus" dogmatises thus, "Conferences are not required, but proper salaries for the curators." He leaves us quite in the dark, however, as to where the proper salaries are to come from. Now I presume that a conference would be the best means of ascertaining the existing state of local museums and of eliciting suggestions for their improvement.

I beg therefore to propose that the subject should be brought forward at the next meeting of the British Association, to be held at York. J. ROMILLY ALLEN

"Herschel and Cameron's Practical Astronomy"

I RECEIVED not long ago by post a pamphlet bound, rather takingly, in red cloth wrapper, with gilt letter title, stamped largely diagonal-wise on the side; which title consisted of these words—"Herschel and Cameron's Practical Astronomy." The title-page assigns the authorship to one "Alex. Mackenzie Cameron," and adds "Revised throughout by Capt. John Herschel, R.E., in charge Astronomical Branch of the Great Trigonometrical Survey of India."

I will not waste your space by describing the contents; but as I am wholly and entirely guiltless of any knowledge whatever of the work, and as the use of my name inside, and of my patronymic outside (the intention of which is obvious), are alike unauthorised, I trust you will grant me so much as is necessary to protest formally against so daring a piracy.

Collingwood, March 20 J. HERSCHEL

P.S.—I transmit the work for your satisfaction. Please consign it to the waste basket.

Meteor

A BRILLIANT meteor was seen here at 7.57 this evening. Course nearly north to south, passing near ζ Ursæ Majoris, and disappearing suddenly nearly over δ Leonis. Colour greenish white, like burning zinc, with trace of a reddish train, but no track visible afterwards. B. W. S.

Hampstead Heath, N.W., March 29

The Audiphone

I HAVE received a number of letters on this subject which I cannot reply to singly. So far as my own experience goes any audiphone is a total failure in about two-thirds of the cases of deafness.

The essential difference between my own form and the others is that mine is light, cheap, does not require to be held with the hand, and, for musical purposes, gives the correct timbre or quality of tone. Colladon's form especially gives a very harsh, rough quality, and is offensive to a musician; the same objection applies also to my own, made in thin sheet metal; and for this reason birch veneer is preferable to any other material I have tried. I have no intention of making them for sale, but in case of any difficulty in obtaining or making one I will forward any required for 2*s*. 6*d*. each, which is about the cost of making. The only trouble is in obtaining a curved surface on which the wood can be fastened whilst wet. My first were made by wetting the veneer, fastening it in a curve with strings and bent pins and allowing it to remain until dry. The surface should then be varnished, first with shellac in spirit and afterwards with the same to which a small quantity of ivory black is added. The natural colour of the wood is unpleasant, as it makes the user look like a dog on a hot day, *i.e.*, as if he had his tongue out a considerable distance.

The amount of deafness does not appear to be of any importance. I know cases of totally deaf people who can hear perfectly with a small audiphone, and others of only partial deafness in which it is a complete failure. THOS. FLETCHER

4, Museum Street, Warrington

A COMET OBSERVED FROM H.M.S. TRIUMPH

CAPT. A. H. MARKHAM, R.N., of H.M.S. *Triumph*, the flagship on the Pacific Station, reports that a comet was observed during the voyage from Payta in Peru, to Manta on the coast of Ecuador. The *Triumph* left Payta on February 7. The comet was first seen on the evening of the 7th at about 8 o'clock. The nucleus was distinctly made out, bearing south-west at an altitude of 7° above the horizon. The tail, a long-spreading one, was not very brilliant, but could be clearly traced to an altitude of 35°, the observed termination bearing about south-south-west. The whole phenomenon subtended an angle with the horizon of about 70°. It was situated in the constellation of Argo Navis, and the direction of the tail was in a line almost equidistant between Sirius and Canopus. It set at about 9.30 p.m.

On the next evening it was again seen at about 8 p.m., but nearer the horizon, which proved that it had been travelling with extraordinary rapidity. Although the nucleus was closer to the horizon than on the preceding evening, the altitude of the end of the tail was 40°, showing that it had increased in size. Clouds banking up to the southward prevented Capt. Markham from observing the time of setting. On the 9th, the third evening of observation, it was very hazy, but the tail could still be seen, resembling the streamer of an aurora, in the same position as on the two previous evenings. At the same time a bright luminous patch was observed immediately under Canopus.

SOCOTRA

THE following letter has been forwarded to us for publication:—

"*Gollowan Bay, Socotra, February* 16

"MY DEAR SIR JOSEPH HOOKER,—Just a line to say how I am getting on; we reached here on the 11th. The Sultan has not yet turned up, but we expect him soon. The *Seagull* could not go round to Tamarida, but put in here at the west end of the island; she leaves again to-day.

"All my things are now landed and my encampment is close to the shore. I have to wait here for the Sultan in order to get camels from him.

"The island is well worth examination. I have already over 150 species of plants besides some birds, lizards, and insects. The flora is splendid. All my plants have been collected within a couple of miles of my encampment. Some lovely Orobanches and Dodders, Stapelias, other Asclepiads, *Aristolochias*, *Adenium* in thousands, and plenty of *Rubiaceæ*. I stick about here for some time, as I may as well do one little bit thoroughly before taking a rapid run over other parts.

"My collector has taken to the animals, and I intend to make him look after them. The geology of the island is curious: granite, diorite, and limestone being all mixed up in a most perplexing way. There is plenty of water, but not sufficient surface soil for much cultivation here, My companion from Aden has unfortunately had a touch of some fever, but is now better.

"Excuse this short note, but I did not expect the *Seagull* to go so soon, and I have a lot of specimens under way which will not keep.

"I am well, and expect great results, and if hard work will produce them they ought to be obtained.

"Sincerely yours,

"BAYLEY BALFOUR

"P.S.—Letter just come from Sultan ordering sheiks here to give me camels and men and everything I want."

CHEMICAL EQUILIBRIUM

THROUGHOUT the history of chemistry two lines of advance may be traced. At one time chemists have endeavoured to answer the question, what does this substance do? At another time they have inquired, of what is this substance composed?

Function and composition have been, and continue to be, the two great guides in the development of chemical science.

Chemistry has always had her kinetical as well as her statical problems.

And in recent times, as dynamical reasonings have been more and more applied to chemical phenomena, we find the broad distinction still prevailing.

"We can already distinguish two lines along which dynamical science is working its way to undermine at least the outworks of chemistry. . . . Of these two lines of advance one is conducted by the help of the hypothesis that bodies consist of molecules in motion, and it seeks to determine the structure of the molecules and the nature of their motion from the phenomena of portions of matter of sensible size. The other line of advance, that of thermodynamics, makes no hypothesis about the ultimate structure of bodies, but deduces relations among observed phenomena by means of two general principles—the conservation of energy, and its tendency towards diffusion" (Clerk-Maxwell, Science Conferences, South Kensington, 1876).

In a paper published in NATURE (vol. xx. p. 530), I endeavoured to give a short sketch of the work of Guldberg and Waage on the influence of mass on chemical action. The theory of these naturalists is largely based on the hypothesis of the molecular structure of bodies and is developed by the application of dynamical reasoning to experimentally determined facts. The theory is a most successful attempt to explain the nature of the motion of certain molecular systems "from the phenomena of portions of matter of sensible size."

Guldberg and Waage deduce the conditions of equilibrium of many representative chemical systems; but they do this by simplifying the phenomena, by considering only the force of affinity, and by overlooking the action of all "secondary forces." They show how chemical equilibrium is modified by changes in the value of the coefficients of affinity, and by changes in the masses of the reacting bodies. They regard each chemical change as proceeding through two or more phases, and as eventually returning to its original phase, and thus completing itself, unless prevented by the action of extraneous forces.

The work of the Norwegian Professors is confirmatory of the kinetic theory of chemical action, that theory, namely, which regards molecular decompositions and recompositions as continuously proceeding even in apparently stable chemical systems.

A most important paper by Prof. Willard Gibbs, of Yale College, bearing on the thermodynamical problem of the equilibrium of chemical systems, appeared some time ago in the *Transactions* of the Academy of Sciences of Connecticut (vol. iii.). This paper was summarised and rendered intelligible to the chemist by the late Prof. Clerk Maxwell in one of those marvellously condensed and suggestive sketches which he, perhaps better than any other naturalist of modern times, knew how to draw. (*loc. cit.*)

Prof. Gibbs deduces from the principles of the conservation and dissipation of energy, a general expression for the stability of any phase of matter with regard to any other phase.

If K represent the stability of a given phase A with respect to any other phase B, then the phase A will tend to pass into the phase B if K is negative; but if K be zero or positive, the phase A is absolutely stable.

K varies with the component masses, volume, and entropy (called *the magnitudes* of the system by Clerk Maxwell), and with the temperature, pressure, and the *potentials* of the component substances (called the *intensities* of the system): "the potential of any component substance is the intensity with which the body tends to expel that substance from its mass."

The phase A may be stable in itself, and, nevertheless, "may have its stability destroyed by contact with the smallest portion of matter in certain other phases."

No absolutely unstable phase can exist for any finite time, but such a phase may form an intermediate stage between other relatively stable phases. Indeed, "the region of absolutely unstable phases is in contact with that of absolutely stable phases at the critical point. Hence, though it may be possible by preventing the body from coming in contact with certain substances to bring it into a phase far beyond the limits of absolute stability, this process cannot be indefinitely continued, for before the substance can enter a new region of stability, it must pass out of the region of relative stability into one of absolute instability, when it will at once break up into a system of stable phases" (Clerk Maxwell, *loc. cit.*).

That certain phases of heterogeneous substances were unstable has, of course, been long known to chemists—although such phases have been almost entirely disregarded in chemical investigations—but we are now taught that not only is the existence of such phases recognised by the great principles of the conservation and dissipation of energy, but that the conditions of their existence, and of their relations to stable phases of the same mass of matter, can be deduced from these principles.

Chemists have long groped after some definite connecting link which should bind their more empirical generalisations with the great principles of energy which are so far-reaching in their application to physical science; the genius of a mathematician seems at last to have revealed the bond.

As examples of what might be called strained equilibrium, that is, of systems carried into phases much beyond the limits of absolute stability, and of the sudden overthrow of the equilibrium by small exciting causes, Prof. Clerk Maxwell notices the case of water, freed from air and surrounded by a liquid of high boiling point, remaining in the liquid state at a temperature much above the boiling point corresponding to the pressure, but exploding instantly it comes in contact with any gas; he also cites the equilibrium of a 37 per cent. solution of calcium chloride when cooled below $-37°$, as described by Guthrie in his researches on cryohydrates.

Many other similar cases might be noted. In my own work I have recently met with certain phenomena which may, I believe, be explained by the general principle now under consideration.

In studying the effects of mass, time, &c., on the decomposition which may be formulated—

$$x\,BiCl_3 + x'\,HCl + x''\,H_2O = (x-n)\,BiOCl + n\,BiCl_3 + \{x' + 2\,(x-n)\}\,HCl + \{x'' - (x-n)\}\,H_2O,$$ [1]

I noticed that if such a quantity of water be cautiously poured on to the surface of a solution of bismuthous chloride in hydrochloric acid, as just suffices to produce a trace of solid bismuthyl chloride (BiOCl) at the surface of contact of the two liquids, and if the liquids be then mixed, the amount of bismuthous chloride which has undergone decomposition after a given time—provided the time be short—is much more than if the water be added to the bismuth solution with constant stirring.

Indeed, I found that it was possible to arrange two systems, each containing the same quantity of $BiCl_3$, HCl, and H_2O, so that one of these should remain clear, *i.e.*, without formation of BiOCl, whilst in the other a considerable amount of decomposition should occur.

[1] Chem. Soc. *Journal, Proc* 1879, p. 311.

The explanation of this phenomenon put forward in the paper alluded to was founded on the molecular hypothesis; but I think that a fuller explanation is afforded by the results of Prof Gibbs's investigations.

When the water was added on the surface, a small quantity of the matter in the vessel instantly passed into another phase; this being in contact with matter in the original phase, induced therein a phase of relative instability, and this succession of phases proceeded until a new condition of stable equilibrium was attained. The entropy of the system was altered by the production of small quantities of BiOCl; K would almost certainly be negative for the new phase with regard to the original phase, and therefore the original phase would become unstable by contact with it of a small portion of matter in the new phase. If, however, the formation of matter in the new phase were prevented by the special contrivance of adding the water in a peculiar way, then the original phase would be stable; if, however, a somewhat large quantity of water were added, the whole system might be carried much beyond the limits of absolute stability without overthrow of equilibrium, but this equilibrium would necessarily eventually be overthrown, as was indeed always found to be the case.

In a paper recently published in the *Journal* of the Chemical Society in conjunction with Mr. Slater, of St. John's College, I detailed the results of an examination of the influence exerted by variations in the amount of water of dilution on the chemical change formulated—

$$BaCl_2 + K_2C_2O_4 = BaC_2O_4 + 2KCl.$$

It is there shown that the progress of this change is retarded to a proportionately greater extent by a large, than by a small quantity of water of dilution, and that this retardation is especially marked when the action proceeds at low temperatures. In order to explain this result we suggested the hypothesis that when much water is present and a low temperature is maintained various hydrates of barium chloride, especially the cryohydrate ($BaCl_2.37H_2O$ solidifying at $-8°$), are produced, and that these, being formed in presence of a large mass of one of the products of their own dissociation, are comparatively stable. We discuss and illustrate this hypothesis in the paper, and, in our opinion, establish for it a fair degree of probability.

Now, if this hypothesis be granted, I think we have in these experiments another illustration of the general principle laid down by Prof. Gibbs.

If $BaCl_2 + K_2C_2O_4$ be called phase A of the system, then undoubtedly K is negative with regard to $BaC_2O_4 + 2KCl$, *i.e.*, with regard to phase B. Phase A is absolutely unstable, and tends to pass into phase B. But during this passage a phase, or phases, is reached which is only relatively unstable. Could the matter in this phase (which may be called the cryohydrate phase) be separated from that portion already in phase B, the intermediate phase might become absolutely stable; this, however, is not done, and hence the whole system tends to pass into phase B. But it is evident that those conditions which favour the formation of matter in the cryohydrate phase must also retard the passage of the system into phase B. Moreover, while the system is in the cryohydrate phase, it is carried to a certain extent beyond the limits of absolute stability, and if this phase were abnormally extended we should expect to obtain a condition of unstable equilibrium liable to complete overthrow by small exciting causes. In the paper referred to we show that such an expectation can be realised.

A class of reactions in chemistry, hitherto treated for the most part as isolated facts, seems to find its explanation in the generalisation now established by the Yale Professor, viz., that the equilibrium of matter in a relatively stable phase may be overthrown by contact with even very small portions of matter in another phase.

As examples of the reactions referred to may be cited, the decomposition of ozone by silver, and of barium peroxide by platinum; the production of diphenylmethane from benzene and benzylic chloride only in presence of a small quantity of zinc or copper; the action of hydrochloric acid on bismuthous oxide in presence of a small quantity of water;[1] and in general those numerous reactions which are modified by the presence of traces of foreign substances.

In other cases contact with small quantities of matter in another phase appears to retard the passage of the main system from its initial phase to a phase of greater stability. Thus Bunsen and Roscoe showed[2] that the resistance to combination of a mixture of hydrogen and chlorine when exposed to sunlight is increased by the presence even of traces of oxygen.[3]

Every chemical system thus appears to tend towards a phase of maximum stability. If the entropy of the system be decreased, K will be increased in the general equation of Gibbs, and hence the stability of the system will be increased.

All chemical systems not in phases of absolute stability will therefore tend to lose entropy.

This is probably a better method of stating Berthelot's so-called *law of maximum work* than that generally employed.

Moreover, it may be possible to convert a phase of absolute stability into a phase of relative stability, and thence into a phase of absolute instability, by contact with matter in another phase, *i.e.*, in ordinary chemical language, by the action of a reagent.

The readiness with which so many chemical systems undergo change leads one to ask whether chemical systems are not generally in one or other of those phases of relative instability which are so easily overthrown by contact with small quantities of matter in other phases. If this be so, and if it be granted as extremely probable, that even apparently stable systems are passing through cycles of change, then we should expect that slight changes in the values of the "magnitudes" or "intensities" of chemical systems would in many cases induce the overthrow of the stability of these systems.

The considerable differences in the properties of many carbon compounds, as described by different experimenters, may not improbably be due to the changes induced in these bodies by contact with small traces of impurities, *i.e.*, of matter in phases other than that of the main portion of the system.

The more complex the possible actions and reactions in any given system of heterogeneous substances, the more probable will be the occurrence of unstable phases, and the more will the course of what we call the chemical change be turned aside by small variations of the "magnitudes" or "intensities" of the system.

In chemical changes involving few intermediate phases —or to put it in another way, in chemical changes wherein the action of "secondary forces" is small—the course of the change may be followed, and generalisations made concerning it, as was done by Harcourt and Esson for a special case.[4] When the action becomes a little more complex, we appear to gain the conditions under which so-called "chemical induction" becomes possible; while from the study of exceedingly complex actions no generalisations can be safely deduced.

This view of chemical systems as readily undergoing change when in contact with other systems, and of these changes as being dependent on the energy of the systems

[1] Examined by me in Chem. Soc. *Journ.*, 1879; *Proc.*, p. 336.

[2] *Phil. Trans.*, 1856.

[3] The modifying influence exerted on a process of chemical change by the presence of a foreign substance was considered in 1850 by Brodie, in an able paper, in which, speaking of the decomposition of barium peroxide by platinum, he says: "The platinum causes that chemical relation between the particles which renders the decomposition possible."

[4] Chem. Soc. *Journ.*, xx. 460.

in different phases, may lead to a fuller explanation of the "acceleration coefficients" of Harcourt and Esson. These chemists found that the change formulated

$$H_2O_2 + 2HI = 2H_2O + I_2$$

was accelerated to a definite extent by addition of sulphuric or hydrochloric acid, but that the accelerating value of each acid was different. The "acceleration coefficients," which they suggested might profitably be found for classes of salts, would measure the changes in the energies of the systems, brought about by the addition of the salts used.

The work of Prof. Gibbs will probably tend to modify the views generally held with regard to the meaning of constitutional or structural formulæ, and to lead us to regard these formulæ as crude representations of the configuration of the molecule when it has passed into the phase preceding that of absolute instability, rather than of its configuration when it is unacted on by matter in a phase different from its own, and is therefore itself in a phase of absolute stability.

Of course the possibility of predicating a general decomposition for a group of compounds, shows that these compounds all tend to pass—under the influence of one and the same reagent—into analogous unstable phases, and that their structure, before contact with the reagent, is therefore probably analogous.

Prof. Gibbs has shown how the laws of energy may be applied to the solution of chemical problems, and in doing this he has opened a new path of advance, and has supplied a guide long sought for by students of chemistry.

M. M. PATTISON MUIR

A LEAF FROM THE HISTORY OF SWEDISH NATURAL SCIENCE[1]

I.

BEFORE the Era of Freedom (1721, 1772) Sweden had produced only four men who had earned for themselves a recognised name in the history of the natural sciences by discoveries in the field of natural research. These were Sigfrid Aron Forsius,[2] unfortunate in his predictions, author of a Mineralogy which had an extensive sale, but is full of superstition, and did not advance the science in any noteworthy degree; the quarrelsome and whimsical Upsala professor, Olof Rudbeck,[3] who, at the age of twenty-five, published his discovery of the lymphatic vessels; the physician of European reputation, Urban Hjaerne,[4] superintendent of one of the first State laboratories established for *scientific* investigation, famous for his researches regarding mineral waters, the increase of weight in metals on their oxidation, and formic acid, the discoverer of several new minerals, &c.; the afterwards so renowned mystic Emanuel Swedenborg,[5] known in the history of the natural sciences for various geological treatises of great excellence, considering the period when they were written, for a remarkable work on atomicity, for several crystallographical researches, for the largest and most complete handbook on metallurgy, &c.

These formed the whole contribution that Sweden, during her period of greatness, was able to make in this field. Here up in the remote north we had, as far as scientific research is concerned, remained completely undisturbed by the discoveries of Copernicus, Descartes, Leibnitz, and Newton, nay, even the original researches of Danish men of science such as Tycho Brahe, Steno, Bartholinus, and Roemer, had awakened no *fruitful* response on our side of the Sound.

There came, however, another period. Our short dream of greatness had come to a bloody termination. Of the Sweden formerly so powerful there remained but a maimed, depopulated nucleus, impoverished by perpetual war, whose part in the labour of the development of the race appeared to have been long ago played out. No glorious interference in the field of politics was any longer possible. But instead there began here, in the peaceful field of science, labours attended with such success that the history of other countries can scarcely show anything corresponding to it.

Our native country, where, as I have just pointed out, there was previously scarcely any scientific research, was for two decades after the peace of Nystad (1721) as fruitful in this field as any cultured state whatever, and some ten years later occupied the first rank in zoology and botany through Linnæus, in mineralogy through Wallerius and Cronstedt, in chemistry through Brandt, Cronstedt, Scheffer, Bergman, Scheele. There were also valuable contributions to the development of physics from Wassenius, Klingenstjerna, Hjorter, Celsius, Wargentin, Wilke, &c., and to the knowledge of our globe through Bergman's excellent "Description of the Globe," and the travels of the numerous pupils of Linnæus. Remarkably enough, this period of greatness in the field of research is almost conterminous in time with that "Era of Freedom" which is often depicted in so dark colours by our writers of history. It was clearly born of the spirit which accompanied the new constitution, and it got its death blow at the revolution by which Gustavus III. is said to have "saved the country."

The object of this paper is to contribute to the history of our civilisation a sketch of the influence which Swedish men of science of that age exerted on the development of chemistry and mineralogy.

The line of the great men of science from that period is headed by George Brandt, Councillor of Mines and Superintendent of the Laboratory of the Mining Board at Stockholm (born 1694, died 1768).

During the seventeenth century and the beginning of the eighteenth most of the writings of authors on chemistry still contain an unintelligible confusion of endless considerations concerning the way in which the bodies on the earth's surface are composed of certain supposed primitive substances, for instance, according to the school of Aristotle, of fire, earth, water, and air; according to Basil Valentine and Paracelsus, of certain elementary principles—salt, sulphur, and quicksilver. The service of having shown the groundlessness of these fancies is to be ascribed to the great English *savant*, Robert Boyle (died 1691). In opposition to his predecessors, he laid down the fundamental principle that the chemist ought to consider every body as simple which with the means at his disposal he cannot chemically decompose, a principle which indeed took from chemistry much of the glitter of learning with which it before was bedecked, and which in the eyes of philosophers reduced this science to an art of cookery, which in any case, when the old creations of fancy, constructed with so much trouble and subtlety, were blown away, gave the science a stable foundation to build on. Boyle's fundamental principle has since been further developed, and now forms one of the corner-stones of the modern chemistry—although it must be admitted that it is little in accordance with the simplicity which otherwise prevails in nature, that the material world should consist of more than sixty different elements. Certain it is in any case that the elements in question, at least for the

[1] Translated from a paper by Prof. A. E. Nordenskjöld, of Stockholm.

[2] Born at Helsingfors after the middle of the sixteenth century; died 1637.

[3] Born 1630, died 1702. His discovery of the lymphatic vessels was published in 1653.

[4] Born 1641; died at Stockholm in 1724.

[5] Swedenborg was born in 1688; died in 1772. The greater portion of his period of activity therefore falls under the Era of Freedom, but most of his scientific works were published before 1721, among them his "Prodromus Principiorum Rerum Naturalium," in which, among other things, he attempts to explain the physical properties of bodies, on the supposition that they are composed of an endless number of minute atoms. His great metallurgic works were first published in 1734. In the *Transactions* of the Royal Academy of Sciences he published, as late as 1763, a "Description of a Method of Inlaying Tables and other Furniture with Marble," free from all mysticism. The table described in this paper is still preserved at the office of the Swedish Board of Trade.

present, cannot be decomposed or transmuted into one another either by the most powerful decomposing agents, by the vital forces of plants, or by fire, or by electricity. They thus form the raw material of which everything in nature, whether living or inanimate, is composed. In such circumstances it is clear that an accurate knowledge of these elements forms the first condition for the development of chemistry, and that the discovery of a new element must often be of such importance as to form an epoch in the history of the science.

This was especially the case at first, when many of the elements that occur most generally in nature, and there play a very important part, were yet unknown, and when nearly every new discovery in that field presupposed a new method of research which could also be employed in other directions. Many questions, too, which now appear self-evident were formerly very difficult of investigation on account of the faulty methods of research which were then generally employed. The history of chemistry during the last century shows that the Swedish school of chemistry was the first that taught the chemist to question nature in the right way, and to arrange his experiments so that to a *proper* question he got a *proper* answer. Urban Hjaerne may be considered as the founder of this school, Brandt as the eldest of his pupils who took part in the development of the science.

The first chemical work by which Brandt gained for himself an honoured name in the history of chemistry was his researches "De Arsenico," and "De semi-metallis," published in *Acta litteraria et scientiarum Sueciæ* (Upsala, 1733 and 1735), in which he showed, among other things, that arsenic, with reference to which the views generally entertained were uncertain and hesitating, must, on account of its physical and chemical properties, be considered a (semi) metal, whose "kalk" is the white arsenic (arsenious acid). Of great importance for the mineral chemistry of that period was also Brandt's research on zinc, by which he showed that galmeja and blende are ores of zinc, and galitzenstein its vitriol.[1] We have him, besides, to thank for important investigations into the causes of cold- and red-shortness in iron, in the course of which he for the first time makes a proper distinction between these two defects, gives a correct explanation of the cause of red-shortness, and, as far as cold-shortness is concerned, comes very near the truth. Further, Brandt published repeated extensive researches regarding the vegetable and mineral alkalies, in which, among other things, he shows (1756) that common salt contains the same alkali as soda, but saltpetre, on the other hand, a vegetable alkali. Thereby the objections were repelled which various chemists had made to the masterly research of the Frenchman, Duhamel du Monceau, published twenty years before, "Sur le base du sel marin."

Brandt, however, is most renowned in the history of chemistry for his discovery of the metal cobalt. The distinguished German mineralogist Agricola, who died in 1555, speaks of certain minerals which, in consequence of their silver-like appearance, were mistaken for silver ores, but which, when an attempt was made to smelt them, only gave off a poisonous smoke, but yielded no noble metal. They were therefore looked upon by the superstitious miners of that time as silver ores which had been changed by mountain goblins or "kobolds," and were thrown away as valueless, until a German glass manufacturer, Schürer, in the middle of the fifteenth century, discovered that they could be used to give a beautiful blue colour to glass. No thorough examination of the blue colouring matter, however, was made until Brandt, in his "Dissertatio de Semi-metallis," published in 1735, showed that it contained a peculiar metal, which he named cobalt. In the cobalt ores formerly known this metal was combined with arsenic, but in 1742 Brandt examined a cobalt ore from Riddarhyttan, in Westmanland, which was found to be free of arsenic, and afterwards obtained the name Linneit. Nearly fifty years after the publication of Brandt's first paper doubts were cast by foreign chemists on the existence of the new metal on the ground of erroneous experiments.

Next in order to George Brandt among distinguished Swedish chemists comes Henrik Theophilus Scheffer, assayer of the mint at Stockholm, born 1710, died 1759. His most famous work is a research on "The White Gold, or Seventh Metal, called in Spain Platina del Pinto" (*Trans.* of the Swedish Academy of Sciences, 1752), in which Scheffer shows by a complete series of experiments that this "wild American variety of silver" forms a new noble metal. Two years before the same substance, which had long been known to the Spaniards, was referred to as a semi-metal, yet without any further clearing up of its chemical properties. In consequence of the many mystic conceptions, not yet completely rooted out, which, from the time of the alchemists, were connected with the idea "noble metal, the ascertaining of the chemical nature of the "white gold" contributed more than could have otherwise been expected to extend and confirm the sound and truly scientific direction which in a couple of decades became predominant in chemical research in our country. We have besides Scheffer to thank for important improvements in the art of assaying gold and silver, and for an excellent series of lectures in chemistry, published by Thorbern Bergman from notes taken by Alströmer, for the first time in 1775, sixteen years after Scheffer's death, and since several times reprinted both in the Swedish and in foreign languages.

A year before the publication of Scheffer's first paper on platinum the *Transactions* of the Swedish Academy of Sciences contained another important research, "Experiments made with a Species of Ore from Loos Cobalt Mines," by Axel Frederic Cronstedt. These mines had a century before been taken in hand by Kalmeter, and the ore at first yielded a good zaffre. But it soon appeared that part of the ore was impure. It was examined by Cronstedt, and found to contain not cobalt, but a new metal. This new metal Cronstedt afterwards found in various other minerals, among others in a German mineral, Kopparnickel, a copper ore changed by a wicked mountain goblin, "Niccol." The new metal, which has now many practical applications, was called nickel, and was immediately, in accordance with the requirements of science, carefully examined, and the tests for it ascertained by Cronstedt. To show what difficulties attended such investigations at that period it may be pointed out that Buffon in 1777 considered platinum an alloy of gold and iron, and that Sage, renowned in France as an analytical chemist, in 1772, and De Lisle even in 1783, considered koppar-nickel a cupriferous ore. Even in 1801 Haüy did not consider it fully established that nickel was a distinct metal. Further, it ought to be mentioned in connection with Cronstedt's chemical activity that he was the first to draw attention to a mineral, "Bastnäs tungsten," from Bastnäs mines in Westmanland, in which Berzelius, Hisinger, and Klaproth in 1803 discovered cerium, and Mosander in 1839 and 1843 lanthanum and didymium. Cronstedt's special greatness, however, did not lie in the field of chemical but of mineralogical research. Here he prepared the way for the new era.

It was natural that a certain practical skill in distinguishing minerals and ores should speedily be developed in a country so rich in mines as Sweden. We scarcely find a trace of it, however, in the older Swedish literature, for the Mineralogy of Aron Forsius is full to overflowing of the sayings of Arabian authors, but contains only notes on nature studies within the land itself. On the other

[1] It is distinctive of the then standpoint of the science, and of the importance which discoveries that now appear of little moment had for its development, that even so late as 1725 the experienced Saxon mineralogist, Henckel, had no suspicion that blende, which is of common occurrence in the Saxon mines, contains zinc.

hand Urban Hjärne's work, "A Short Introduction to Research into Various Kinds of Ores and Rocks, Minerals, &c." (Stockholm, 1694), fortunately written not for the learned but for searchers for ore, unfolds practical views of the subject, and he has in reality connected his name with several new observations in science. Not till after 1720, however, did there commence among us in this field a new period. As early as 1730 Bromell published a little, modest but serviceable Mineralogy, which enables us easily to understand the standpoint of the science at that date. Afterwards Linnæus included the mineral kingdom along with the others in his "Systema Naturæ" (first edition, 1735), and attempted to apply in that branch of knowledge the method of going to work which he had used with such success in describing and arranging the products of the animal and vegetable kingdoms. In this way at a later date he gave the exciting touch to De Lisle's work, which created an era in this field. The method of Linnæus was followed by Gottskalk Wallerius, who published in 1747 the first real Handbook of Mineralogy, a work incomparably better than anything that had been written on this branch of knowledge since the time of Agricola. For not only in it was collected all that was previously known in science, but the work was rich in new discoveries. Yet Wallerius still places among the true species of minerals, petrifactions and stone-like concretions from the animal and vegetable kingdoms, pearls, hair-balls, &c.

It was reserved for Cronstedt to sweep these matters out of mineralogy, and thus draw a correct boundary line between the products of the mineral and animal kingdoms, and to lay the foundation of geognosy by making a proper distinction between minerals and rocks. The work in which these new discoveries were brought together was published, without the author's name, at Stockholm in 1758, under the title, "An Essay on Mineralogy; or, an Exposition of the Mineral Kingdom," afterwards reprinted in a new edition and translated into Danish, English, and German (two editions). In order to give an idea of the revolution in science which Cronstedt carried through, not without violent opposition, I take the following extract from the polemic introduction to his work:—

"Sand is in itself nothing else than small stones, and therefore, if we give sand a place by itself we ought to do the same to pebbles, to earthfast stones, and lastly to rocks. This is just a *multiplicatio entium præter necessitatem*.

"Stones of beasts and fishes are composed partly of phlogiston, salts, and a small proportion of earth, partly of the same matter as the bones of animals, and there is therefore no more reason for including them in a mineral system than the stones of fruits. Soot, tartar, yeast, and such like are too nearly related to the vegetable kingdom. . . . Hair-balls and hat-stuff are so far different that the former is felted together in the entrails of animals *per motum peristalticum*, and the latter by the industry of human hands. May we suppose, then, that hair-balls and animal-stones cannot be included among *relicta animalia?* . . . Meanwhile I flatter myself that those who will follow the introduction here given will not be put to so much trouble with the matters belonging to the mineral kingdom as has happened to myself and others from previously published systems, and that I thus will get some defender against those who are so infected with figuromania and taste for outside work that they are offended at the presumption of passing off marble as limestone, and of placing porphyry among rocks."

This introduction is distinctive of the reform which Cronstedt carried through in mineralogy, and it is distinctive of the standpoint of science before Cronstedt's time that the alteration, so necessary and self-evident as it now appears to be, at first aroused controversy and opposition. To this it conduced in its degree that Cronstedt in general fixed less attention on the outward appearance of minerals than on their chemical properties, to ascertain which he employed the blowpipe with great skill and success. Numerous were the new discoveries with which in this way he enriched the science, and during a quarter of a century his "Essay on Mineralogy" was an unsurpassed *chef-d'œuvre*.

Two years after Cronstedt's death Wallerius retired from his professorship of chemistry in the University of Upsala, and after a lively contest the post was assigned to Thorbern Bergman (born 1735, died 1784), then mathematical assistant. He had not previously made himself known by any *chemical* writings, but from that time he devoted himself with such industry and success to chemical research that within a short time he won for himself a European reputation and the name of being the first chemist of his time. His researches embraced nearly all branches of the chemical science of the period; everywhere he dragged new facts into light or corrected older erroneous statements. Space permits me here only to point to his development of the new chemical analysis in the wet way, and the researches he carried out by the new methods on the most dissimilar substances, for instance on different kinds of iron, by which the composition of pig iron, malleable iron, and steel was first ascertained, on precious stones and siliceous minerals, on a number of salts, &c.; to his comprehensive research on carbonic acid (called by him atmospheric acid), whereby the discoveries of Black, Macbride, and Cavendish relating to this exceedingly important substance were considerably extended and the foundation of the chemistry of carbonic acid laid; to his analyses of mineral waters, in which even their gaseous constituents were estimated; to his examination of the salts of bismuth, zinc, lead, nickel, gold, platinum, and magnesia; to his services to organic chemistry; and finally to his laborious investigation of the laws of chemical attraction, which are still recognised in the science, though in a form much altered, by the labours of Berthollet and others. Bergman also did great service to mineralogy by his comprehensive analytical researches and by his "Sciagraphia Regni Mineralis," the best systematic work on mineralogy since the time of Cronstedt.[1]

Finally, we may further state that Wallerius and Bergman were the founders of agricultural chemistry, the former by his disputation, "Agriculturæ fundamenta Chemica," published in 1761, in Latin and Swedish; the latter through a work, "De Terris Geoponicis," which was communicated to the Academy at Montpellier, and for which he received a prize in 1773. An incalculable service has also been conferred by the Swedish chemists on the development of scientific agriculture by their pointing out the common occurrence of phosphorus in nature, in the mineral kingdom by Gahn in 1780, in the bones of animals by Gahn or Scheele before 1771.[2]

Carl Wilhelm Scheele lived and worked at the same time as Bergman. He did not possess the many-sided learning and deep theoretical insight of the Upsala professor, but, instead, an unsurpassed power of scientific divination, which enabled him, the young apothecary, to mark nearly every year of his short period of activity by "original contributions to chemical science, which, by the influence they exerted on industry, metallurgy, and agriculture, contributed more powerfully than diplomatic negotiations or pitched battles to the development of the

[1] Bergman's works were for the most part published in the first place as academic disputations or in the *Transactions* of the Swedish Academy of Sciences, but they were afterwards collected in "Opuscula Physica et Chemica," 6 vols., Upsala, 1779. There are numerous translations into foreign languages.

[2] Phosphoric acid, as is well known, forms a constituent in most manures. It was first discovered by the Hamburger Brand (not to be mistaken for George Brandt) in 1669, and, when he kept his discovery secret, a second time by Kunkel (German chemist, for the last twenty-five years of his life mining counsellor in Stockholm, and ennobled by Charles XI. under the name of Löwenstern). That the generally-occurring mineral *apatite* contains phosphoric acid was discovered by Klaproth and Proust in 1788. That bone, horn, &c., may be used as manures was known to Bergman (see *Opuscula*, v. page 106).

last hundred years, and secured him, the modest apothecary of Köping, a place in the first rank of the men of science of all ages and of all countries."

In a succeeding paper I propose to give a sketch of the work of Scheele, and to return at the same time to the chemical labours of Bergman.

(*To be continued.*)

THE TEMPERATURE OF SPACE AND ITS BEARING ON TERRESTRIAL PHYSICS

FEW questions bearing directly on terrestrial physics have been so much overlooked as that of the temperature of stellar space, that is to say, the temperature which a thermometer would indicate if placed at the outer limits of our atmosphere and exposed to no other influence than that of radiation from the stars. Were we asked what was probably the mid-winter temperature of our island 11,700 years ago, when the winter solstice was in aphelion? we could not tell unless we knew the temperature of space. Again, without a knowledge of the temperature of space, it could not be ascertained how much the temperature of the North Atlantic and the air over it were affected by the Gulf Stream. We can determine the quantity of heat conveyed into the Atlantic by the stream, and compare it with the amount received by that area directly from the sun, but this alone does not enable us to say how much the temperature is raised by the heat conveyed. We know that the basin of the North Atlantic receives from the Gulf Stream a quantity of heat equal to about one-fourth that received from the sun, but unless we know the temperature of space we cannot say how much this one-fourth raises the temperature of the Atlantic. Suppose 56° to be the temperature of that ocean: this is 517° of absolute temperature which is derived from three sources, viz.: (1) direct heat from the sun, (2) heat from the Gulf Stream, and (3) heat from the stars. Now unless we know what proportion the heat of the stars bears to that of the sun we have no means of knowing how much of the 517° is due to the stars and how much to the sun or to the Gulf Stream.

M. Pouillet and Sir John Herschel are the only physicists who appear to have devoted attention to the problem. The former came to the conclusion that space has a temperature of − 142° C. or − 224° F., and the latter, following a different method of inquiry, arrived at nearly the same result, viz., that its temperature is about − 239° F.

Can space, however, really have so high a temperature as − 239°? Absolute zero is − 461°. Space in this case would have an absolute temperature of 222°, and consequently our globe would be nearly as much indebted to the stars as to the sun for its heat. If so space must be enormously more transparent to heat rays than to light rays. If the heat of the stars be as feeble as their light, space cannot be much above absolute zero, and this is the opinion expressed to me a few weeks ago by one of the most eminent physicists of the day. Prof. Langley is also of this opinion, for he concludes that the amount of heat received from the sun is to that derived from space as much as four to one; and consequently if our luminary were extinguished the temperature of our earth would fall to about − 360° F.

It must be borne in mind that Pouillet's Memoir was written more than forty years ago, when the data available for the elucidating the subject were far more imperfect than now, especially as regards the influence of the atmosphere on radiant heat. For example, Pouillet comes to the conclusion that, owing to the fact of our atmosphere being less diathermanous to radiation from the earth than to radiation from the sun and the stars, were the sun extinguished the radiation of the stars would still maintain the surface of our globe at − 89° C., or about 53° C. above that of space. The experiments of Tyndall, however, show that the absorbing power of the atmosphere for heat-rays is due almost exclusively to the small quantity of aqueous vapour which it contains. It is evident, therefore, that but for the sun there would probably be no aqueous vapour, and consequently nothing to protect the earth from losing its heat by radiation. Deprived of solar heat, the surface of the ground would sink to about as low a temperature as that of stellar space, whatever that temperature may actually be.

But before we are able to answer the foregoing questions, and tell, for example, how much a given increase or decrease in the *quantity* of sun's heat will raise or lower the *temperature*, there is another physical point to be determined, on which a considerable amount of uncertainty still exists. We must know in what way the temperature varies with the amount of heat received. In computing, say, the rise of temperature resulting from a great increase in the quantity of heat received, should we assume with Newton that it is proportional to the increase in the quantity of heat received, or should we adopt Dulong's and Petit's formula?

In estimating the extent to which the temperature of the air would be affected by a change in the sun's distance, I have hitherto adopted the former mode. This probably makes the change of temperature too great, while Dulong's and Petit's formula adopted by Mr. Hill (NATURE, vol. xx. p. 626), on the other hand, makes it too small. Dulong's and Petit's formula is an empirical one, which has been found to agree pretty closely with observation within ordinary limits, but we have no reason to assume that it will hold equally correct when applied to that of space, any more than we have to infer that it will do so in reference to temperature as high as that of the sun. When applied to determine the temperature of the sun from his rate of radiation, it completely breaks down, for it is found to give only a temperature of 2130° F. (*Amer. Jour. Science*, July, 1870), or not much above that of an ordinary furnace.

But besides all this it is doubtful if it will hold true in the case of gases. From the experiments of Prof. Balfour Stewart (*Trans.* Edin. Roy. Soc., xxii.) on the radiation of glass plates of various thicknesses, it would seem to follow that the radiation of a material particle is probably proportionate to its absolute temperature, or, in other words, that it obeys Newton's law. Prof. Balfour Stewart found that the radiation of a thick plate of glass increases more rapidly than that of a thin plate as the temperature rises, and that, if we go on continually diminishing the thickness of the plate whose radiation at different temperatures we are ascertaining, we find that, as it grows thinner and thinner, the rate at which it radiates its heat as its temperature rises becomes less and less. In other words, as the plate grows thinner its rate of radiation becomes more and more proportionate to its absolute temperature. And we can hardly resist the conviction that if it were possible to go on diminishing the thickness of the plate till we reached a film so thin as to embrace but only one particle in its thickness, its rate of radiation would be proportionate to its temperature, or, in other words, it would obey Newton's law. Prof. Balfour Stewart's explanation is this: As all substances are more diathermanous for heat of high than low temperatures, when a body is at a low temperature only the exterior particles supply the radiation, the heat from the interior particles being all stopped by the exterior ones, while at a high temperature part of the heat from the interior is allowed to pass, thereby swelling the total radiation. But as the plate becomes thinner and thinner, the obstructions to interior radiation become less and less, and as these obstructions are greater for radiation at low than high temperatures, it necessarily follows that, by reducing the thickness of the plate, we assist radiation at low more than at high temperatures.

If this be the true explanation why the radiation of bodies deviates from Newton's law, it should follow that in the case of gases where the particles stand at a considerable distance from one another, the obstruction to interior radiation must be far less than in a solid, and consequently that the rate at which a gas radiates its heat as its temperature rises, must increase more slowly than that of a solid substance. In other words, in the case of a gas, the rate of radiation must correspond more nearly to the absolute temperature than in that of a solid; and the less the density and volume of a gas, the more nearly will its rate of radiation agree with Newton's law. The obstruction to interior radiation into space must diminish as we ascend in the atmosphere, at the outer limits of which, where there is no obstruction, the rate of radiation should be pretty nearly proportional to the absolute temperature. May not this to a certain extent be the cause why the temperature of the air diminishes as we ascend?

If the foregoing considerations be correct, it ought to follow that a reduction in the amount of heat received from the sun, owing to an increase of his distance, should tend to produce a greater lowering effect on the temperature of the air than it does on the temperature of the solid ground. Taking, therefore, into consideration, the fact that space has probably a lower temperature than − 239°, and that the temperature of our climate is determined by the temperature of the air, it will follow that the error of assuming that the decrease of temperature is proportional to the decrease in the intensity of the sun's heat may not be great.

In estimating the extent to which the winter temperature is lowered by a great increase in the sun's distance there is another circumstance which must be taken into account. The lowering of the temperature tends to diminish the amount of aqueous vapour contained in the air, and this in turn tends to lower the temperature by allowing the air to throw off its heat more freely into space.

JAMES CROLL

THE RUSSIAN GEOGRAPHICAL SOCIETY

IT is no easy matter to render an account of the proceedings and publications of the "Imperial Russian Geographical Society." So numerous are its sections, and so prolific is each of them, that to master the whole of the information yearly made available by them would be no easy task, even for a reader possessing the amount of leisure which most Russians enjoy. Some of its volumes, however, are intended merely as works of reference, books which are not meant to be read through, but which serve as useful storehouses of facts and figures. Of such a nature is the huge collection now before us of *Pistsovuiya knigi*, the rent-rolls, as it were, of the estates of ecclesiastical and lay proprietors of the soil in the sixteenth century. Some idea of the magnitude of the work may be gained from the fact that the second part alone of its first volume contains 1,598 large and closely printed pages. As a general rule, the publications of the Society are of no use to foreigners who are unacquainted with Russian. But there are a few exceptions, such as the monograph by Prof. Oswald Heer, of Zurich, on the fossil flora of the coal-fields of East Siberia. In 1859 a rich collection of fossil plants was made in the Amur district by F. Schmidt, but it was burnt in the great fire of Blagoveshensk the year after. In 1862 a fresh collection was made, and submitted to Prof. Heer. The results of his investigations are given in the second division of "the geological part" of the third volume of "the physical section" of the Records (*Trudi*) of the "Siberian Expedition" of the Society, under the title of the "Jurassic Flora of the Irkutsk Government and the Amur Territory." The greater part of the text is in Russian. But as the descriptions are in Latin, and they are accompanied by thirty-one quarto plates, printed at Winterthur, the book is available for Western scholars. The expedition of the late A. Tchekanovsky to the Lena in 1875, says the editor, F. Schmidt, in his preface, has contributed new and important additions to our knowledge of the Jurassic flora of Siberia. "The Jurassic plants collected around Bulun and Ayakit, Lower Lena, serve as a link between the Jurassic flora of South-East Siberia and the same flora of the Spitzbergen Isles, and prove the unity and comparative uniformity of the Jurassic flora over a great part of the northern hemisphere, namely from Spitzbergen to England (Yorkshire) and beyond the Lena to the Irkutsk Government and the Amur." Much valuable information about Siberia is given also in the voluminous supplements to Ritter's "Asia," "serving as a continuation of Ritter's work, based upon materials rendered available since 1832."

Among the subjects treated at greatest length in the *Transactions* (*Zapiski*) of the Ethnographical Section of the Society are "The Shores of the Frozen and White Seas," "The Church Calendar of the Common People," and the "Popular Juridical Customs of the Russian Empire." The treatise on the first gives a full account of the various tribes inhabiting the inhospitable northern shores. In speaking of the Samoyeds, it may be worthy of remark, the author does not even so much as allude to the absurd explanation (dear to many English minds) of their name as meaning cannibals. *Lyudoyed*, in Russian (from *lyudi*, men, and *yest'*, to eat), signifies a cannibal. A false analogy has resolved Samoyed into the same meaning. If it meant anything in Russian, it would mean a "self-eater," whatever that might be. Russian philologists explain it in different ways. Some, as Lerberg, consider it a Russian word, corrupted from Semgo-yed, a salmon-eater. Byelyavsky says that the Samoyeds employ, in speaking of each other, a common tribal or family designation Khasovo, from *Khaz*, self (in Russian *sam*) and *ovo*, one (in Russian *odin*). From these Russian equivalents of the Samoyed words, sprang, he supposes, a designation Sam-odin or Sam-yedin. In some old documents the Samoyeds are called Suiroyadtsui, from their habit of eating raw (suiroe) meat. But there seems to be no reason for supposing that the two names have any connection. Much more probable is the surmise that the word is of Finnish origin, the land belonging to some Ugrian neighbours of the Samoyeds having been called Samoyanda or Samoyedna, from which the Russians formed the name Samoyed. The Calendar gives a detailed account of the Saints' days observed by the Russian peasants, and of the various superstitions and rites connected with them. It begins with September, which was officially chosen as the first month at the Council of Moscow in 1342. In ancient days March was among the Russians, as it was among the Israelites, the commencement of the new year. Its modern name, *Mart*, was derived from Rome through Byzantium; the heathen Slavs knew it as Sukhy, "the Dry," or Berezozol, from its effect on the *bereza* or birch-tree.

The volume devoted to the juridical institutions of the common people, their civil and criminal law courts, is full of interest; and the information it contains is thoroughly trustworthy, having been carefully collected and sifted by the members of a Commission appointed for the purpose in 1876. It embraces not only the village-jurisprudence of the Russians themselves, but also that of the strangers within their gates, and the wild tribes of their outlying provinces. Of great interest also are the numerous volumes of Reports (*trudui*) issued by the members of the Ethnographical-Statistical Commission appointed to explore the western provinces of Russia. The seven large volumes devoted to the south-western governments give an exhaustive account of Little-Russia, entering into most minute details concerning the physical and moral character of the inhabitants of that part of the empire, between whom and the

Great-Russians so considerable a difference exists. Vol. I. deals with the superstitions of the peasants, especially as regards witchcraft, to which subject Prof. Antonovich of Kief has devoted a long and interesting essay. According to him, the popular ideas about the subject are "not demonological, but pantheistic." And the authorities seem to have looked upon wizards and witches with some indulgence. In a hundred trials of persons accused of witchcraft in the eighteenth century, he finds scarcely any trace of such cruelty as was shown at an earlier period by British or German legal officials, or by the Inquisition in the south of Europe. Burnings were unknown. Convicted warlocks were generally mulcted in a fine paid to the Church. In the few cases in which they were punished more severely, the unusual harshness of the court was due to the fact that the complainant belonged to the class of nobles. The second volume contains a valuable collection of 146 skazki or folk-tales, 31 of which are classed as "mythical." It forms an important supplement to Rudchenko's excellent "Collection of South-Russian Tales." Vols. iii.–v. contains an immense number of folk-songs, and a list of days to which the peasants pay special attention. The sixth volume is devoted to popular jurisprudence in general and the village courts in particular, and the seventh to statistics, giving a complete account of the Little-Russians themselves, and of the rest of the population, whether of Polish, Jewish, or other extraction.

TEMPERATURE OF THE SOIL DURING WINTER

THE French physicists, Edmond and Henry Becquerel, took advantage of the intense cold prevailing at Paris last December, to study the changes in temperature below the surface of the soil under various conditions. It is a widely-spread belief among farmers, that when protected by a layer of snow, crops sown in the autumn are effectually guarded against freezing. This opinion, however, must lose much of its weight in view of these late observations, which we will briefly summarise.

The observations were made by means of Becquerel's electric thermometer, which consists simply of two wires isolated by a coating of gutta percha, and soldered together at their extremities. Differences in temperature between the two places of junction cause electric currents varying in intensity with the greatness of the difference. A magnetic needle, brought under the influence of the current, registers on a dial these differences. The wires were inserted in the Jardin des Plantes at various depths varying from 5 to 60 centimetres, and observations were made from November 26 to the close of December. Frost first appeared in the Garden November 26. December 3 snow fell in abundance, and the temperature of the air sank to $-11°$ C. The layer of snow was 25 centimetres deep. December 10, the temperature had sunk to $-21°$, and commenced then gradually to rise. December 15, the snow was 19 centimetres in depth.

Coming now to the observations made below the surface of the ground under the above circumstances, we find at once a striking difference between the results obtained in soil covered with grass, and those obtained below a bare surface of the ground. In soil protected by grass, before as well as after the snowfall, at all depths below that of 5 centimetres, the temperature never descended below 0° C. Registering 3°·5 at the depth of 5 centimetres on November 26, it slowly sank to 0°·18 on December 14. The presence of grass would appear, then, to effectually protect the earth beneath it from freezing at the lowest temperatures attained in our climate. Quite different results, however, are yielded in the absence of grass. In this case at a depth of 5 centimetres the thermometer sank below zero on November 27. Two days later it registered $-$ 2°·6. On December 3, just before the snowfall, it reached its minimum of $-$ 3°·17. After being covered with snow it registered $-$ 0°·8, and later $-$ 1°·4. The snow here appears to act in a certain measure as a screen against changes in temperature, but its conductive properties are still too marked to prevent these changes from being felt sensibly at a certain depth in the earth. In the case of the agriculturist, this slow conduction, when united to the still slower conductive properties of a tolerably thick layer of dead shoots of cereal crops sown in autumn may frequently insure immunity from freezing to the roots below the surface.

T. H. N.

NOTES

WE regret to have to announce the death of P. W. Schimper, the well-known Professor of Palæontology in the University of Strassburg, and of Dr. R. H. C. C. Scheffer, the amiable and accomplished director of the Botanic Garden, Buitenzorg, Java, at the early age of thirty-five. Also of two foreign entomologists —Herr Hellmuth von Kiesenwetter at Dresden, in the sixtieth year of his age, and Dr. Snellen van Vollenhoven, formerly Conservator of the Leyden Museum, one of the foremost entomologists of Holland, and author of "Faune Entomologique des Indes Orientales."

WITH reference to Prof. Smyth's communication in regard to the exhibition of aurora on March 17 (NATURE, vol. xxi. p. 492), we are informed that the photographic records of the Royal Observatory, Greenwich, show that there was also magnetic disturbance on that day.

DR. W. FARR has been made a C.B.

DR. C. WILLIAM SIEMENS has been elected an honorary member of the American Institute of Mining Engineers.

THERE has just appeared, as Vol. XII. of the Report of the United States Geological Survey of the Territories under Dr. F. V. Hayden, an important monograph on the Freshwater Rhizopods of North America by Dr. Joseph Leidy, the eminent comparative anatomist of Philadelphia. It is a well-printed quarto, and sumptuously illustrated with a series of forty-eight coloured plates. Containing the results of an investigation of materials partly collected during the prosecution of the Survey, it shows the broad scientific spirit in which the operations of Dr. Hayden's Survey were conducted. Dr. Leidy, almost elbowed out of the field of research among the fossil vertebrates of the West, where he was the earliest pioneer, has left that field in possession of his younger friends, Professors Cope and Marsh, and has betaken himself to another and very different domain of scientific research, with which he has long been familiar. To the monograph which he has now issued we hope to call attention in an early number of this journal.

A NEW School of Agriculture is to be opened, to be called the South Wiltshire and Hampshire Agricultural College, at Downton, near Salisbury, on April 26. Among the teaching staff will be: Prof. Wrightson for Agriculture, Prof. Church, Chemistry; Prof. Fream, Natural History and Geology; and Prof. Sheldon, Dairy Work. Attached to the college is a mixed farm of 540 acres, to be worked by the students themselves.

AT the Royal Institution on Tuesday next (April 6) Prof. Huxley will give the first of a course of two lectures on Dogs and the Problems connected with them; on Thursday (April 8) Prof. Tyndall will give the first of a course of six lectures on Light as a Mode of Motion; on Friday evening (April 9) Prof. Huxley will give a discourse on the Coming of Age of the Origin of Species; and on Saturday (April 10) Mr. James Sully will give the first of a course of three lectures on Art and Vision.

THE large glass disk which has been cast by M. Feil of Paris is not, we are informed, intended for Paris, but for Pulkowa; the Paris glass is already in the hands of the opticians. The exact weight of the Pulkowa disk is 195 kilog. The annealing will be finished next week, after a duration of about twenty-one days. After the completion of the operations M. Feil will begin the casting of the great Pulkowa flint lens. It will weigh 220 kilog., and the time of annealing will be about five weeks.

BY permission of M. Hervé Mangon, M. Raoul Pictet has given, in the great amphitheatre of the Conservatoire des Arts et Metiers, a lecture on the Artificial Production of Cold, a question which has become exceedingly practical in Paris, to the discussions raised by the impending transformation of the Morgue. MM. Dumas, Fremy, and other scientific notabilities of Paris were present at the lecture, which will be followed by others, the intention of M. Hervé Mangon being to give similar privileges to any competent person wishing to promulgate any scientific theories.

THIS week the French scientific world is very busy in Paris. The French Association for the Advancement of Science and the delegates of the Sociétés Savantes are holding their meetings at the Sorbonne and other places on the occasion of the Easter holidays. On Friday evening the Société de Physique will hold their annual meeting. The long-expected and deferred reception of Nordenskjöld will very likely give a new interest to all these demonstrations.

MR. PHILIP MAGNUS, B.Sc., B.A., has been elected to the post of Organising Director and Secretary of the City and Guilds of London Technical Institute. The number of applications was fifty-eight. The Drapers' Company having offered a sum of 10,000*l.* towards the new buildings projected for a school of applied science at Cowper Street, conditionally upon an equal sum being raised to meet it, 5,000*l.* is already provided, and it is thought that other companies will be not unwilling to assist in this matter by contributing the remaining portion.

THE court of assistants of the Clockmakers' Company, to encourage the highest excellence in the production of the marine chronometer, have determined to award annually two prizes to the makers of the two chronometers which shall perform with the greatest accuracy under the conditions prescribed by the Astronomer-Royal at the annual trials at the Royal Observatory, Greenwich. The first prize will consist of ten guineas and the freedom of the company, and the second prize five guineas.

VESUVIUS, the Naples correspondent of the *Daily News* telegraphs last Friday, as usual during full moon, shows greatly increased activity. Two new mouths opened last night at the foot of the new cone, sending jets and red-hot stones to a great height, while the lava issued from the central crater. The same correspondent gives some details as to the railway up Vesuvius. The station is situated on a level spot on the west side of the mountain, about half-an-hour's walk from the observatory. The constructors of the railway have adopted the American double iron rope system. There are two lines of rails, each provided with a carriage divided into two compartments and capable of holding six persons. While one carriage goes up the other comes down, thus establishing a counterpoise which considerably economises the steam of the stationary traction engine. The incline is extremely steep, commencing at 40°, increasing to 63°, and continuing at 50° to the summit. Every possible precaution has been taken against accident, and the railway itself is protected against possible flows of lava by an enormous wall. The ascent will be made in eight to ten minutes, while before it required from one to two hours. To obtain the necessary supply of water, large covered cisterns have been constructed, which in winter will be filled with the snow that often falls heavily on Vesuvius. This snow will be quickly melted by the internal heat, and, besides the water thus obtained, the frequent rainfall will also be conducted into the cisterns.

THE Naples correspondent of the *Daily News* gives, in yesterday's issue, an interesting account of the rise and progress of the zoological station at that city; with most of the facts our readers are already familiar. Several Governments—Italy, Prussia, Russia, Holland, Belgium, Switzerland, Bavaria, Saxony, Würtemburg, Baden, Hesse, Hamburg—have each one or more tables, the British Government being conspicuous by its absence. The Italian Ministry of Marine thinks of hiring a table for the use of the marine officers, to enable them to learn the methods of fishing and preservation of specimens, in order to make collections during their long voyages. Altogether nineteen tables are engaged, which represent an income of 40,000 francs. The income arising from the public aquarium has never yielded more than a sum of 20,000 francs per annum. The remaining expenses have hitherto been covered by subventions from the Imperial German Government, and it is to be hoped that a new yearly subvention of 40,000 francs, which has been petitioned for by the most celebrated scientific men of Germany, and granted by the German Parliament, may be consented to by the Government. The correspondent gives several facts to show the wide utility of this station and its influence on the progress of science.

ON Sunday week a shock of earthquake was felt throughout Moldavia.

A GENERAL meeting of the Mineralogical Society of Great Britain and Ireland will be held in the University of Edinburgh on Monday, April 5, at 3 p.m. (by permission of the *Senatus Academicus*), Prof. W. F. Heddle, F.R.S.E., president, in the chair. The following paper, with others, will be read:—"On the Microscopic Structure of some Vitreous Basalts," by Prof. A. Geikie, F.R.S. On this occasion the attendance of gentlemen interested in mineralogy is invited, whether Members of the Society or not.

THE *Photographic News* is responsible for the following:—Everybody knows how jealously the gates of the Royal Observatory are guarded, and what difficulties even scientific men have to gain admission. But Mr. Glaisher, the worthy President of the Photographic Society, and who was until lately Superintendent of the Meteorological Department, tells a story that goes far to prove that nothing is impossible to a resolute man. A vast star shower had been anticipated and its coming heralded in every newspaper. The staff at Greenwich, with the Astronomer-Royal at their head, remained the whole night through making observations and counting the bright meteors as they fell. The weary night passed, and the small hours of the morning came, only to find the jaded observers still pursuing their duty. "That makes 10,704," said our friend Mr. Glaisher. "Beg pardon; how many?" exclaimed a voice behind him. "10,704," repeated the President of the Photographic Society; and then, not recognising the voice, he turned and saw a stranger: "Who are you, and where do you come from?" At first, the only possible conjecture was that the stranger had fallen from the clouds along with the star shower; but it was not so, for, closing a little note-book, he simply replied, "I am the special correspondent of the *New York Herald*. Thank you very much. Good morning." How that special managed to get through the park gates and elude the vigilance of the keepers; how he got inside the walls of the Observatory; how he pressed into the sanctum of the Astronomer-Royal is a mystery to this day; but within a few hours of his interview with Mr. Glaisher the readers of the *New York Herald* printed a correct account of the marvellous star shower, together with many interesting details of the Observatory itself.

CONSUL LAYARD sends us the following notes of literary or scientific blunders, brought to his recollection by the article on "Subject-Indexes" in NATURE, vol. xx. p. 554. We rather think the Cape story is a replica of a still older one in the mother country:—"Some years ago, when we moved into the combined South African Library and Museum buildings, several volunteers assisted in placing the books in the shelves. One morning the librarian, with an amused smile on his face, showed me a book he had found among the medical works; it was Burton's 'Anatomy of Melancholy!' Next day it was back again! and while we were wondering who had so placed it, the culprit came forward and applauded himself for mending the work of 'some stupid fellow' who did not know where to place medical books! A friend sent me Miller's 'Old Red Sandstone.' It burst its cover in the post-bag coming from England, and a discussion arose as to whom it might have been sent. At last some one suggested I was the most likely owner of a work of that class, and I was summoned. On arriving at the P.O. with the sender's letter, I accosted the P.M.G. with the remark that I believed the book then in his hands was mine. 'It is,' I said, 'the "Old Red Sandstone," by Miller, who wrote'—I was going to adds 'The Testimony of the Rocks,' when my old friend cut me short with—'Yes, yes, I know, the jokes, the jokes'!! Shades of old Joe! I gravely acquiesced, and walked off with my book."

THE observations in which Prof. Pavesi of Pavia has been lately engaged on the pelagic fauna of the lakes of Tessin and of Italy have yielded interesting results (of which there is an account in the *Archives des Sciences*, February 15). Some twenty-one lakes were examined, mostly in Italy. The tables show that *Leptodora* is found almost everywhere. *Daphnella brachyura*, *Daphnia hyalina*, *D. galeata*, *Bosmina longirostris*, *Cyclops minutus*, &c., are very common; on the other hand, *Sida crystallina*, *Daphnia quadrangula*, *Bosmina longispina*, and *Bythotrephes* are rare; lastly, *Daphnia magna*, and *D. crystallina* are localised in the single Lake of Idro. It is a curious fact that of two lakes, near each other and of the same geological origin, and frequented by the same aquatic birds, one may present hardly any pelagic forms, while the other may have many. Such are the small Lake of Candia and the Lake of Viverone (they also show a difference of the opposite kind in algological flora). The latter lake, indeed, is triple that of the former, and about five times as deep. Still, great depth is not necessary to existence of pelagic animals, though it is more favourable to their development; *e.g.*, they multiply in the lakes of Brianza and Endine, which are only ten metres deep. Some forms, as *Bythotrephes*, are found only in the deepest lakes. As to the bathymetrical limits of the fauna, *Leptodora* lives generally, by day, at about 15m. depth. At 10 and 30m. it is generally rare, though in some cases it has been found even at 100m., and in shallow lakes is common at 5m. *Daphiura cristata* of Lake Idro is common at 5 to 15m., very rare at 50m. *Daphnia magna* is most abundant at 30 to 50m. On stormy days few forms were found at 5m. depth. The almost absolute absence of crustacea in the Lake of Garda, at 5 m. even in calm weather, is attributed to the great transparency of the water. Prof. Pavesi thinks the influence of temperature nil or inappreciable. He assigns a marine origin to the fauna in question; fiords changed to lakes, part of the isolated species dying out, others becoming adapted to new conditions of life, diffusion of these forms, by various means of transport, to neighbouring lakes of different epoch and origin, such as the lakes of Switzerland, Bavaria, and Lake Trasimeno. This confirms Stoppani's theory of the origin of the lakes in Upper Italy.

THE *Journal of Applied Science* draws attention to a statement that has recently been made to the effect that in Thuringia, in Germany, over 1,000 tons of dried beetroot leaves are annually passed off as genuine tobacco. Beetroot, chicory, and cabbage are largely used for a similar purpose in Magdeburg and in the Palatinate. The "Vevey" cigars, which are in such favour in South Germany, contain no tobacco at all, but are entirely composed of cabbage and beet-leaves, deprived of their natural smell and taste by a special form of cultivation, and subsequently steeped in tobacco water for a lengthened period.

THE importance of the German element in the United States is evidenced by the publication of a *Deutsch-Amerikanische Apotheker-Zeitung*, the first number of which we have received.

THE West Kent Natural History Society present a satisfactory *Report* for 1879; it contains the address of the president, Mr. R. McLachlan, F.R.S., in which he finds something new to say about the house-sparrow.

THE Report of the Bristol Museum and Library for 1879 shows that the institution suffered somewhat in its income from the general depression, though otherwise it continues to meet with favour. The museum especially has received several valuable additions.

IN the last number of the journal published by the Newcastle-on-Tyne Chemical Society is a paper by Mr. W. G. Strype on "An Apparatus applicable to the Continuous Testing of Chamber Escapes."

AMONG the papers in No. 3 of the *School of Mines Quarterly* of Columbia College, to which we referred some time ago, we may mention Prof. Newberry's on "The Origin and Classification of Ore Deposits;" interesting notes on Mexican Mining, by Mr. J. C. F. Randolph; "Aërostation," by Mr. J. A. Navarro; and a paper on "Soap," by Mr. A. L. Colby.

THE Rev. W. Clement Ley asks us to state that in his letter in NATURE, vol. xxi. p. 48, he wrote "the Hon. R. Abercromby," not "Sir R. Abercromby."

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. J. R. Cullin; two Striped Hyænas (*Hyæna striata*) from Arabia, presented by Capt. the Hon. F. G. Hay and Mr. Wylde; an American Red Fox (*Canis fulvus*) from North America, presented by Capt. Russell; a Carpet Viper (*Echis carinata*) from India, presented by Capt. C. S. Sturt, C.M.Z.S; two Golden-Headed Parrakeets from Brazil, an Eyton's Tree Duck (*Dendrocygna eytoni*) from North-West Australia, purchased; a Crested Pigeon (*Ocyphaps lophotes*) from Australia, a Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, deposited; a Sambur Deer (*Cervus aristotelis*), an Eland (*Oreas canna*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE SOUTHERN COMET.—Dr. B. A. Gould, Director of the Observatory at Cordoba, publishes the results of hasty observations of the head of the southern comet on the evening of February 4. It appeared "like a coarse, ill-defined mass of dull light 2′ or 3′ in diameter, and without visible nucleus." Two determinations of position were made by placing it in the middle of the field of the large equatorial and taking the readings of the circles. Thus Dr. Gould obtained the following place after correcting for refraction, and it should be mentioned that at the second observation the comet's altitude was less than 2° 42′; right ascension, 22h. 24m. 10s.; declination, − 31° 29′·1 at 5h. 27m. 55s. Cordoba sidereal time, which corresponds to February 4 at 12h. 46m. 25s. Greenwich mean time. Mr. Finlay's orbit, which appeared in this column last week, gives the right ascension greater by 1° 29′ and the declination further south by 21′; though the Cordoba observation is called a rough one, under the circumstances it will hardly be liable to such errors, and may be at least comparable in accuracy with the approximate positions received from the Royal Observatory at the Cape. If we combine it with the Cape places on February 10 and 15 for the determination of the orbit, the following remarkable elements result—we say remarkable from their being almost identical with the elements of the grand comet of 1843, as will be seen from the orbit annexed:—

	Comet of 1880.	Great comet of 1843 (Hubbard's parabola).
Perihelion passage	Jan. 27·6027	
	° ′	° ′
Longitude of perihelion	279 6·8 ...	278 35·1
,, ascending node ...	4 1·9 ...	1 20·6
Inclination	35 39·8 ...	35 38·2
Log. perihelion distance	7·77371 ...	7·74123
Motion	Retrograde ...	Retrograde

If this close resemblance is the result of accident, and the true orbit of the comet more like that published last week, the coincidence is a very unusual one in such computations, and in fact not far from an unique case.

Prof. Hubbard, from his rigorous investigation of the orbit of the great comet of 1843, concluded that the period extended to several centuries, though before the comet was beyond reach of the telescope it was conjectured that the revolution might be comparatively short, and from a similarity in the appearance of the comets of 1668, 1702, and 1843, a period of about thirty-five years was considered probable by many astronomers. Pending the arrival of accurate observations from the southern hemisphere, which may decide the true form of orbit, it may be worth while to examine with large telescopes the vicinity of positions calculated from the orbit which so closely resembles that of the comet of 1843, as, in the event of identity, observations of position made now would have great value. For 8h. Greenwich mean time the above orbit gives the following places:—

	R.A.	N.P.D.	Log. distance from Earth.
	h. m.	° ′	
April 2 ...	4 59·6 ...	98 22 ...	0·2978
4 ...	5 3·2 ...	97 58 ...	0·3104
6 ...	5 6·7 ...	97 36 ...	0.3224
8 ...	5 10·0 ...	97 15 ...	0·3338

PHYSICAL NOTES

M. Ducretet has made the important observation that "toughened" glass is less easily penetrated by the electric spark than ordinary glass. He proposes to apply this discovery in the manufacture of superior Leyden jars. It is almost needless to point out that a means of making powerful condensers of more compact form is afforded by the employment of the toughened article. The very important bearing of the matter upon the whole question of dielectric strain and the elastic recovery of bodies is a point which will probably receive due attention at the hands of physicists.

The residual charge of the Leyden jar has been recently investigated afresh by Herr Giese (*Wied. Ann.*, No. 2). It seemed desirable to follow the course of formation of this charge under conditions more amenable to analytical treatment than has hitherto been the case, and to make the phenomenon independent of external influences. This he sought to attain by determining the quantity of electricity which flowed to the coatings when the difference of potential was kept constant. His method is fully detailed in the paper referred to, and the result he is led to is that the formulæ of Riemann (who offered the hypothesis of an antelectric state of matter, at a meeting of scientists in Göttingen in 1854) are not in harmony with experiment.

A paper by Prof. Rammelsberg, "On the chemical monography of the mica group," has lately appeared in Wiedemann's *Annalen* (Nos. 1 and 2). As to the kind of relations that exist between the chemical nature of micas and their other properties, he remarks that there are differences in corresponding angles, though the amount can be ascertained only in few cases. Optical differences can be determined with more certainty; in this respect all alkali-micas, whether containing sodium, potassium, or potassium and lithium, are alike. The plane of the optic axes is at right angles to the plane of symmetry. Pure magnesia-micas are the opposite in this respect. Among the iron-magnesia-micas there are some which are optically like the alkali micas, but more which are like the pure magnesia-micas. In the lithium-iron micas of Zinnwald the axes are as in the last-mentioned micas. The baryta-mica of Sterzing is optically like the alkali-micas. From all this it results that any classification of micas can only be a chemical one. But so long as we do not know whether the (qualitative) chemical nature coincides with the subdivision hitherto adopted (muscovite, phlogopite, biotite, &c.), which however rests only on physical differences, we cannot exchange the certain chemical names with those which are derived from some special physical character, *e.g.*, the position of the plane of the optic axes.

To the scientific applications of centrifugal force which have been made since the time of Musschenbrœk, who, in his treatise on Physics, calls attention to the utility of it, Prof. Thury of Geneva (*Arch. de Sci.*, January) thinks the following might be added:—Measurement of the adhesion of liquids and solids; separation, total or partial, of a dissolved body from its solvent; separation of the constituents of alloys (kept in fusion by means of Bunsen burners); separation of liquids of different densities; production of high vacua; modification of crystalline forms (possibly); depolarisation of electrodes in some circumstances of electrolysis; modification of the organisation of embryos in the egg; observation of a body in very rapid circular motion, as if it were motionless.

Signor Agostini finds (*Natura*, 3) that if through a drop of mercury, lying on a surface not wet by it, a current be sent in vertical direction, it rotates under the influence of the earth's magnetism, as may be seen if a few particles of lycopodium powder be strewn on it. Similarly a mercury drop rotates when placed on the surface of a steel magnet, and *e.g.* the magnet connected with the positive pole of a very weak element, while an electrode penetrating the drop from above is connected with the negative. From the strength and direction of rotation of a number of such drops one may in general make visible the distribution of the magnetism, the neutral points, &c., both in the magnetic bars themselves, as when an iron bar is brought coaxially near to one end, or into contact; also in the latter. The results of previous experimental measurements are thus confirmed.

GEOGRAPHICAL NOTES

Prof. Nordenskjöld reached London on Friday last, several days after he was expected, thus upsetting all the arrangements which were made for his reception. He is, we understand, to leave for Paris to-day to receive the Great Gold Medal of the Geographical Society and the distinction of Commander of the Legion of Honour. While here he has been entertained in a quiet way by various distinguished people; among others by the Swedish Minister, the Earl of Northbrook as president of the Geographical Society, Mr. Spottiswoode, president of the Royal Society, Sir Allen Young, and others. Doubtless he will return to London at a time more convenient to give him the public reception which he merits.

It is stated that Lieut. Bove, who accompanied Nordenskjöld in the *Vega*, has gone to Rome to submit to the King of Italy and the cabinet a plan for an Italian expedition to the South Pole.

A letter recently received from Capt. Howgate mentions that, whether aided or not by the (U. S.) Government, he is determined to start an expedition to the Arctic regions this year. The s.s. *Gulnari* is now on the "ways," being fitted up for ice navigation under the superintendence of Capt. Chester, who was with Hall in the *Polaris*. A house of wood—double boarded —21 × 68 feet, modelled after those used by the Hudson's Bay Company, is being constructed for the men to winter in on the shores of Discovery Harbour, and will be ready by April 1. A steam launch will probably form part of the expedition.

The Japan papers state that the Russian Government have determined to despatch a man-of-war to make a hydrographical survey of the Japanese seas and the Sea of Okhotsk. The Geographical Society of St. Petersburg have been invited to send a representative with the expedition, and it is believed that Prof. Amantevitch will be selected on account of his knowledge of the Japanese language and the dialects spoken on the east coast of Siberia.

Mr. G. F. Easton, the agent of the China Inland Mission at Tsin-chow in the Kansu province, has sent home an account of a journey which he made last summer to Si-ning-fu and other almost unknown cities on the north-western frontier of the empire. After leaving the main road he travelled west to Ho-chow, and thence pushed along the border country to Shun-hwa-ting on the bank of the Yellow River, crossing which he moved on to Ba-rung and thence to Si-ning-fu, where he stopped six days, returning by way of Lan-chow-fu. It may be interesting to note that many of the places visited by Mr. Easton are not marked on European maps, though he says they are shown on a Chinese map published in book form at Wu-chang. Near the Yellow River Mr. Easton found himself amongst the Sah-la, who differ little in appearance and habits from the Chinese, though they have an entirely distinct language; he also met a few Tu-ren—usually called the Tu-li tribe—who are also Mohammedans, and within a few miles of Si-ning-fu there are several other tribes. To his surprise, at Si-ning Mr. Easton found Count Bela Szechenyi, Lieut. Kreitner, and Mr. Loczy, of the geological department at the Vienna Museum. Mr. Easton states, presumably on the authority of Count Szechenyi, that the altitude of Si-ning-fu is 8,600 feet, and that of Tsing-hai, or Koko-Nor, 10,500 feet, while Lan-chow is about 5,000 feet above sea-level. The correct position of Si-ning is stated to be 36° 33′ 32″ N. lat., 102° 24′ 35″ E. long. Some Germans had recently arrived at Lan-chow-fu to commence a woollen manufactory there for the Chinese, but Mr. Easton does not speak hopefully of their condition or prospects.

FROM a native Japanese paper we learn that the idea of opening Shimonoseki, on the Inland Sea, to foreigners has been abandoned, and that Nairi, in the province of Buzon, Kiushiu, has been selected as an open port in its place.

DURING his recent journey from the head of Lake Nyassa to Lake Tanganyika, Mr. James Stewart, C.E., who is now permanently attached to the Livingstonia mission of the Free Church of Scotland, visited four different tribes, of whom but little has previously been heard. The first was the Chungu tribe, on the lake-shore and inland up to the head of the Songwe valley; their country is described as good and cattle are numerous; iron, too, is abundant and much worked. This tribe, however, is by no means strong, owing to nearly every village being independent. The next tribe visited was the Anyamauga, whose country extends to the Mera River. To the west of them is Mambwe, under a young and intelligent chief, whose people are industrious ironworkers. In the hills round the south end of Lake Tanganyika are the Akandi tribes, all speaking different dialects. They are much harassed by the Babemba. To the north, near the Fipa Mountains, the people are Basukuma, who are separated from the Anyamauga by the River Saisa. At Lake Hikwa, the name of which has hardly been heard of before the journeys of Messrs. Stewart and Thomson, and the position of which is not at present fully identified, the people are Abanda and Apimbwe, while the Chosi River is the boundary between the Mambwe and Babemba. We are glad to learn that Mr. Stewart promises to send home immediately a map and section of his route, together with additional data, which cannot fail to be of interest from a geographical point of view.

THE French Exploring Expedition for the Trans-Saharan Railway has left Wargla for the interior of Africa.

THE METEOR SHOWER OF JANUARY 2

FROM amongst the extensive number of annually recurring meteoric displays there are few comparable, either in point of richness or brilliancy, with the January meteors. The Leonids, Perseids, and Andromedes severally form showers of greater intensity at the epochs of their periodical returns, and there can be no question that the Perseids, as an annual phenomenon, stand unsurpassed, but with the exception of these special instances, perhaps none of the many streams of shooting stars deserve a higher place than that which heralds the opening of the year. The Lyrids, Orionids, and Geminids are entitled to be considered of equal importance as affording an annual spectacle of much interest, though the former system appears during its last few returns entirely to have lost the splendour which characterised its exhibitions in former years. The January meteors, while thus meriting whatever significance is attached to a shower of the first order, have not, it must be admitted, been observed with half the diligence awarded to some other streams of similar nature. An explanation is probably to be found in the circumstance that it does not become thoroughly well visible until the morning hours. The radiant point situated at 230°·5 + 51·3° (15° following η Ursæ Majoris) in a region comparatively bare of stars, though never below our horizon, is yet, during the first half of the night, at a very low altitude, and thus its operations are limited, though not sufficiently so to cause the apparent extinction of the display. In the early evenings of January, 1879 and 1880, it furnished many fine meteors ascending in long courses from the direction of the northern horizon, and appearing in sufficient numbers to cause remark amongst ordinary persons quite unaware of the progress of a notable star shower.

I have been speaking of this phenomenon as one of annual occurrence, but it is fair to conclude that it also possesses the elements of periodical fluctuations, as in the case of the Leonids and Perseids. Prof. Kirkwood, in a paper read before the American Philosophical Society on November 21, 1873, remarked upon this shower as one giving evidence of recurring brightness. He found, chiefly by the comparison of observations made during the present century, that its principal manifestations took place in the years 1825, 1838, and 1864, from which he inferred a periodic time of thirteen years. This would have indicated a maximum in 1877, but nothing of it was seen, though the shower has been very active since that period. Whether or not the investigations of Prof. Kirkwood have allowed the determination of its periodical maxima is a point to be settled by future observations. The history of the shower, as recorded in past years, is too incomplete to afford the materials for anything like a reliable estimate of the period of its revolution. Many times it has wholly escaped record, and even during its visible returns it is seldom witnessed with success. The state of the sky, the time and manner of observation, all affect the results to a considerable degree, and will often occasion apparent variations in the annual appearances of a shower which have no real existence. And it must be borne in mind that from the indefinite descriptions of former showers, it is sometimes impossible to ascribe a fair weight or to detach actual facts from the wild and often exaggerated notices of such phenomena.

Though no good correspondence has yet been detected between a cometary orbit and the orbit of this stream, it is none the less important that the precise centre of divergence of its meteors should be ascertained. Mr. Greg placed it at 232° + 49° from an average of seven independent observations (see his catalogue of the radiant points and durations of meteor-showers in the B.A. Report, 1876), and found a closely adjoining shower of rather later date, which he regarded as distinct at 225° + 54° for the period January 1 to February 6. The mean of the two is 228°·5 + 51°·5, which presents a singularly near agreement with the centre of the shower as I have recently determined it from all the available observations of the radiant point, which have been compared together as follows:—

Radiant Points of January Meteors.

No.	Epoch.	Radiant. α δ	Observer.
1.	Dec. 15–Jan. 15 ...	231° + 53° ...	E. Heis.
2.	Jan. 15–31	227 + 54 * ...	E. Heis.
3.	Jan. 2, 1863	238 + 46·5 ...	S. Masters.
4.	Jan. 2, 1864	234 + 51 ...	A. S. Herschel.
5.	Jan. 2, 1867	228 + 55 ...	Herr Bornitz.
6.	Jan. 29–Feb. 6	223 + 54 * ...	Greg and Zezioli.
7.	Jan. 2–3	238 + 45 ...	Greg and Herschel.
8.	Jan. 2–7, 1870	229 + 51 ...	G. L. Tupman.
9.	Jan. 2–3, 1872	227 + 49 ...	A. S. Herschel.
10.	Jan. 2, 1872	228 + 52 ...	T. Crumplen.
11.	Jan. 1–15, 1872 ...	228 + 53 ...	W. F. Denning. From the Italian Observations.
12.	Jan. 2–3, 1873	234 + 48 ...	T. W. Backhouse.
13.	Dec. 12 and 21, 1876	221 + 53 * ...	W. F. Denning.
14.	Jan. 4, 1877	231 + 54 ...	W. F. Denning.
15.	Jan. 20, 1877	220 + 52 * ...	W. F. Denning.
16.	Jan. 2, 1878	222 + 55 ...	A. S. Herschel.
17.	Jan. 2, 1879	230 + 51 ...	W. F. Denning.
18.	Jan. 2, 1880	228 + 54 ...	W. F. Denning.
19.	Jan. 2, 1880	232 + 55 ...	H. Corder.
20.	Jan. 2, 1880	230 + 48 ...	H. Corder.

Mean position = 229°·0 + 51°·7 from twenty observations, but the four positions distinguished by asterisks are not sufficiently accordant in epoch to be considered as certain displays of the same shower. Omitting them, the resulting mean from the remaining sixteen estimates is = 230°·5 + 51°·3, which seems the most reliable centre for the true shower-meteors of January 2, and nearly coincides with the radiant (No. 8) observed by Major Tupman in 1870 and that (No. 17) determined by the writer in 1879.

That this meteor-cluster is comparatively seldom witnessed, arises from several causes. Cloudy weather offers a frequent impediment. The presence of the moon is also, in some years, a great drawback to successful observation. Moreover, the unfavourable situation of the radiant point in the evening hours considerably lessens the splendour of its display at the most convenient period for observation. In the clear, frosty mornings at the beginning of January the enthusiasm of amateur meteor-observers is seldom sufficient to keep them long out of doors. Yet a few interesting observations of this shower have been made during the past few years both in the morning and evening hours. In 1872, on the night of January 2, between 10.15 and 11.15, Mr. W. H. Wood of Birmingham descried "a fine shower of bright meteors at the rate of twenty per hour for one observer; 42 per cent. were from the usual radiant point. The meteors were of slow apparent speed, train-bearing and vari-coloured." It was also well observed that year by Prof. Herschel and Mr. Crumplen at London. In 1873 Mr. Backhouse re-observed it in the morning of January 2, between 5 and 7 A.M., when meteors were appearing at the estimated rate of thirty-seven per hour. During the three ensuing years this stream appears to have eluded observation. On the evening of January 4, 1877, it was slightly seen by the writer, and on the morning of January 2, 1878, 4 to 4.30 A.M., Prof. Herschel at Hawkhurst in Kent, noted seventeen of its meteors, indicating a very active though transient return of the shower, for a similar watch on the nights before and after its visible display revealed no sign of its appearance. It was seen again in 1879 by Prof. Herschel on the evening of January 1 and morning of January 2, and again with almost equal brightness on the evening of January 2, producing eight or ten fine shooting-stars per hour in each watch. The shower was also recorded by the writer on the morning of January 2. Watching the sky between 6.15 A.M. and 6.35 A.M., no less than fourteen of its meteors were traced, though the greater part of the heavens was veiled in clouds.

The last return of the shower was witnessed by Mr. Corder at Chelmsford on the evening of January 2. He maintained a watch of about 3¼ hours between 6 and 10 P.M., seeing 66 shooting-stars, of which 48 were conformable to Quadrans (15 per hour). The radiant point appeared double at the points 232° + 55° (36 ✱ s) and 230° + 48° (12 ✱ s).

At Bristol the writer saw 25 meteors before 9·30 P.M., but frequent clouds interrupted regular observations—19 of the meteors observed diverged from the usual radiant point in Quadrans (at 228° + 54°). Generally they were of more than ordinary brilliancy, with paths averaging 15½°. Three bright meteors were registered as follows:—

Date.	Time. h. m.	Mag.	Path. α from δ	α to δ	
Jan. 2, 1880 ...	6 16	= ♃ ...	253° + 44° ...	261° + 38°	Slow.
,, ...	7 50	= ♃ ...	138 + 41 ...	126 + 29	,,
,, ...	9 8	= ♃ ...	32 + 60 ...	353 + 56	,, Train.

The third belonged to a radiant either in Perseus or Auriga. Mr. Corder appears to have obtained a duplicate observation of the second, and he gives the path as recorded by him from 248° + 70° to 290° + 79°. The projected radiant from the combined observations is at 232° + 52°. A smaller meteor recorded later (at 8.40) at both stations may also supply another accordance:—

Bristol ...	308° + 73° to 358° + 54°	Radiant point at γ Boötis.
Writtle ...	328 + 52 to 343 + 41	

The meteors of this special shower present some varieties of appearance which are, no doubt, to be explained by differences in the sensible position of the radiant point and by their apparent distances from that centre. In the evening the meteors traverse long flights with moderately slow motions, but in the morning hours their paths are short and the velocity seems increased. They are sometimes accompanied by trains and occasionally faint streaks remain on the courses, but they obviously belong to a different class to the swift, streak-leaving meteors of Perseus, Leo, and Orion.

There is a good radiant point not far south of that of the true January meteors which the writer has seen several times in December and January at 221° + 42°, and Zezioli traced it on January 19, 1869, 220° + 39°. The meteors are extremely swift and leave streaks, but the shower is of far less intensity than the Quadrantids of January 2, from which it may always be dissociated without much difficulty.

W. F. DENNING

ON THE ASIATIC ALLIANCES OF THE FAUNA OF THE "CONGERIAN" DEPOSITS OF SOUTH-EASTERN EUROPE[1]

THE molluscan fauna of Lake Baikal, lately made known by MM. Dybowski and Gertsfeld, is altogether different from the Palæarctic fauna, and is connected by many of its forms with the fresh-water fauna of the "Congerian" deposits of South-eastern Europe; thus it may be regarded as the northernmost outpost of a peculiar south-and-east molluscan fauna. On the other hand the fauna of the Amoor region, quite Palæarctic on the whole, includes some members that approach North American types; while some Chinese *Viviparæ* are conspicuously different from their Palæarctic congeners, and come near both to American forms and to those of the "Congerian" Paludina-beds. In R. P. Heude's "Conchyliologie fluviatile de la Province de Nanking," descriptions and figures are given of thirty-nine species of *Unio*, twenty of *Anodonta*, and five of *Mycetopus*. In Anderson's "Zoological Results of the two Expeditions to Western Yunnan," pl. lxxx., fig. 5, shows a gigantic knobbly-ribbed *Vivipara*, from Lake Tali, quite analogous to its Slavonian congeners. It is concluded that the Upper Miocene flora of Eastern Europe as well as the fauna of the Paludina- and Unio-beds, bears a Chino-Japanese rather than a North American character.

Besides the "Congerian" beds, with their abundance of *Congeria* and *Cardium*, and the Paludinal deposits, characterised by the prevalence of *Vivipara* and *Unio*, a third zone is distinguishable among the upper freshwater tertiaries of South-east Europe, namely, the "Melanopsis-marls," with ornate *Melanopsides* and abundant *Neritinæ*. The only known localities of these marls are the Balkan Peninsula and some of the Greek islands. Even from this limited region we have already thirty-six species of *Melanopsis* and ten of *Neritina*, besides the eleven species of *Melanopsis* and nine of *Neritina* from the South-east European "Congerian" deposits. The genus *Neritina* seems to be especially associated with islands. Lovel Reeve enumerates eight species from Tahiti, eleven from the Sandwich Islands, and thirty-nine from the Philippines; Gassies numbers forty from New Caledonia; Kobelt eleven from the Mediterranean region; about twenty species, nearly all highly ornate, belong to this region. L. Reeve mentions seven species from the West Indies, and ten from Central America. The two or three known North-American species are from the south frontier regions; New Zealand numbers only two species. Extensive continental groups of strata are deficient in *Neritinæ*. The genus is wanting in Africa, East India, the Malayan Archipelago, Australia, and nearly the whole of America.

The species of *Melanopsis* found in the East-European deposits point, by their alliances, to the Mediterranean region; the *Neritinæ* rather to the Philippines and New Caledonia. This last island has many species of *Melanopsis*, and its fauna is somewhat analogous to that of the "Melanopsis-marls." In both cases a great number of species of both genera abound in a limited area; whilst the Mediterranean species are spread over a far wider region.

The fauna of the "Congerian" deposits is known to be closely allied to that of the Caspian; and the facts above-mentioned indicate that the alliances of the uppermost South-east European tertiaries are to be looked for within the Asio-Australian region, the supposed affinity to North America having been suggested in absence of a better knowledge of the Chino-Japanese fauna and flora.

The total absence of the African type of elephant in the upper-terrestrial tertiaries of South Europe is very remarkable, especially as the mammalian fauna of that period has a decidedly African character. As to the flora of the tertiary period, Europe had a succession of Australian, Indian, Japanese, and Mediterranean floras, but never one of African character. The tertiary terrestrial and freshwater molluscs of Europe are analogous to those of New Caledonia, India, China, and Japan, but not to

[1] By Th. Fuchs, Imper. Geolog. Instit. Vienna, Report of September 30, 1879.

those of Africa, although this continent is so near to Europe, and its mammalian fauna at the diluvial period was in intimate connection with that of Southern Europe.

ON THE ORIGIN OF THE MINERAL, STRUCTURAL, AND CHEMICAL CHARACTERS OF OPHITES AND RELATED ROCKS[1]

THE authors, beginning with (A) "The different kinds of rocks treated of," in their memoir, divide them into two groups. The first, "Silacid Ophites," is represented by serpentinite (common at the Lizard) and other rocks, essentially composed of serpentinous minerals: it includes a sub-section, comprising peridolites and some others, all slightly hydrated. The second, "Silocarbacid Ophites," consists of rocks, which, in addition to serpentinous minerals, contain a mineral carbonate—for example, ophi-calcite; its sub-section is represented by hemithrenes. The relation of the first group, through its sub-section, to ordinary metamorphic rocks, also of the second group, through its sub-section, to carrarites and dolomites is pointed out.

As regards (B) "Their mineral character," it is stated that ophites, &c., embrace some fifty or more different minerals, all containing more or less hydrous silicate of magnesia, in addition to which dry silicates and carbonates are often present. The relation of these minerals to others, essentially anhydrous, as hornblende, diallage, and peridote, is noticed.

Treating on (C) "The structural character of ophites, &c." the protean nature of their essential mineral, serpentine, is shown by a description of its fibrous, arborescent, coccolitic, platy, and other allomorphs.

With reference to (D) "The origin of certain mineral, structural, and chemical characters of ophites, &c.," the subject is treated of under different heads:—1. Fibrous layers in peridote from Elfdalen, in "graphic granite" from Harris, in perthite from Siberia, and in other instances. 2. The alternation of different minerals in laminated ophicalcite and ophimalacolite has its parallel in other and totally different rocks. 3. The change of the fibres of chrysotile into aciculæ, separated by calcareous interpolations, is illustrated by figures taken from decalcified and polarised specimens of this allomorph from Canada; also from a characteristic specimen of the same from the type-locality, Reichenstein. 4. Branching configurations, such as are assumed by serpentine, are common in hemithrenes from widely different regions; the authors refer to examples, showing that they are residual, resulting from the waste of crystalloids of malacolite. Beautiful examples occur in the calcaire saccharoide (a hemithrene) of St. Philippe, near St. Marie-aux-Mines, in the Vosges, rivalling those in Canadian ophite; and not only are the associated lobulated grains of pyrosclerite covered with a fibrous layer, closely resembling chrysotile in structure; but its fibres are occasionally converted into aciculæ, separated by films of calcite. 5. The presence of calcite under the latter condition, and in connection with configurations of serpentine and malacolite, as well as lobulated grains of these and other minerals, the authors ascribe to chemical changes similar to pseudomorphism among minerals. 6. It is contended that no minerals are incapable of resisting changes of the kind, even those regarded as the most insoluble. The experiments of Bischof, the Professors W. B. and R. E. Rogers and others, show that hypersthene, enstatite, serpentine, and various mineral silicates, digested in water containing carbonic acid, are convertible into carbonates. 7. Cases are mentioned of rocks, essentially composed of mineral silicates, which have thus become changed; as diorite from Jersey, granite and a porphyritic feldsite from near Galway, which have had certain of their mineral silicates replaced by serpentine and calcite.

The latter cases bring on a chapter (E) "On rock-metamorphism generally." The authors divide metamorphic rocks into two groups—mineralised, and methylosed; the former consisting of members which have had their original sedimentary components mineralised into gneiss, hornblende-schist, &c.; and the latter of members thus mineralised, but which, through the intervention of chemical reactions, have been converted into ophites, &c.; methylosis is to rocks the same as pseudomorphism to minerals. After briefly referring to the theory promulgated by Leibnitz in his "Protogæ," which anticipated many points now generally held as to the origin of the metamorphics, they examine the doctrine advocated by Sterry Hunt; and contend that it is altogether untenable, both from his own arguments, and a body of unquestionable counter-evidence. Repudiating a doctrine which regards the rocks in question as still being in their original or quasi-original condition, formed at the bottom of a primæval ocean, through the chemical precipitation of substances which it held in solution, the authors express themselves in accordance with the prevailing opinion that they were originally ordinary argillaceous, arenaceous, and other sediments, which, through being buried at great depths, have undergone various changes—some ending in their mineralisation, and others in their methylosis. Sterry Hunt's doctrine is further contested by evidences adduced of regional metamorphosism pertaining to various post-Archæan periods, whose crystalline or mineral effects are identical with those which he restricts to pre-Cambrian ages, and which he presumes to have been produced by chemical precipitations from seas of the time.

The mineralised metamorphics having thus far principally engaged their attention, the authors next touch upon the (F) "Methylosed metamorphics—ophites." Taking, as their standpoint, the carefully worked out conclusion of Blüm, Bischof, Rose, and others, that serpentine, as a mineral, is in all cases the product of pseudomorphism, it is contended that rocks essentially made up of it, adding other secondary minerals in certain kinds, have necessarily undergone chemical changes. Cases are cited, such as the serpentinite of the lizard, which they were the first to show, from its containing pseudomorph crystals after augite, had been originally a porphyritic dolerite. One of the Cannover Isles, in Lough Corrib, contains a mass of serpentine, which is shown to be a methylosed diorite or tremolitic rock.

The evidences offered by Bischof, Heddle, and other writers, as to the conversion of serpentinous and other siliceous rocks into calcareous masses are adduced by the authors in confirmation of their view respecting (G) "The methylotic origin of hemithrenes, &c." Additional original evidences are brought forward with the same purport. A volcanic or doleritic dyke intersects gneiss on Mr. Frederick Twining's estate, adjacent to Cleggan Bay, Connemara; where, not only is the gneiss converted into hemithrene, consisting of malacolite, peridote, serpentine, calcite, and other minerals, but the dyke itself is charged with calcitic matter. Another case occurs at St. Philippe, Vosges, where gneiss incloses dyke-like masses of hemithrene, as to conclusively prove, in the opinion of the authors, that the latter are chemically changed products of the former, effected by permeating streams of heated water containing a carbonate in solution. The labours of Delesse have shown that the region around abounds with masses of the kind.

The rocks described having undergone such remarkable changes, the authors have been induced to make investigations as to (H) "The origin of the minerals characteristic of ophites, &c., especially peridote." With certain exceptions the minerals referred to are considered to be of secondary origin, the exceptions being those remaining unaffected by secondary agencies. Serpentines, malacolite, phlogopite, chlorite, enstatite, and a number of others are all considered as secondary minerals. Peridote, notwithstanding that it is generally considered to be an original mineral in the same sense as the hornblende, feldspar, mica, &c., of granite and other plutonic rocks, is regarded by the authors as a product of alteration in all its relations, and circumstances of occurrence. Its presence in granites, basalts, and lavas has given rise to the belief that it is of igneous origin: nevertheless, its occurrence in mineralised and methylosed rocks (gneiss, and ophite of the sedimentary section) is held as proving the contrary; and the authors feel themselves justified in assuming that it is as much a secondary product as the zeolites and pseudomorphs found in granites, basalts, and lavas. Many of the crystals occurring in basalts and lavas, which have been taken for peridote, are in their opinion pseudomorphs after augite and hornblende.

Repudiating the doctrine that the Archæan rocks are the result of chemical precipitations, and entertaining the strongest doubts that life has been to any extent concerned in their formation, the authors, in a chapter (I) "On the origin of the Archæan crystallite limestones of Canada," apply their views on hemithrenes to the present subject; and they arrive at the conclusion, from various considerations, that the rocks in question are methylosed products; but which, before this change took place, existed as gneisses, hornblende-schists, and other mineralised silacid metamorphics.

The question (J) "Why limestones are so rare in formations

[1] Paper read at the Royal Society by Professors W. King, Sc.D., and T. H. Rowney, Ph.D.

immediately succeeding the Archæans" is discussed in connection with the facts that calcareous organisms are rare or not present in the formation referred to, and that calcareous rocks are abundant in the preceding systems—the Archæans. These facts are held to be in unison with the authors' conclusions stated in the last chapter, and to favour the view that the Archæan limestones with their present constitution were not available as materials for the production of calcareous rocks in the earliest Cambrian age.

(K) "The genetic difference between mineralised and methylosed metamorphism" is explained by assuming that water has been an important factor in both cases; but as the minerals in the first group are for the most part anhydrous or dry species, it is assumed that the original (? hygroscopic) water, which its members contained in their condition as sediment, was sufficient for their mineralisation; on the other hand, as the minerals composing the members of the second group are chiefly hydrous, it is contended that their methylosis has been effected by additional water penetrating them, and flowing from extraneous or foreign sources. Compared with each other, mineralised rocks may be classed as xerothermal, and methylosed as hydrothermal.

Various evidences are adduced to show that (L) "Some ophites have been originally igneous, and others sedimentary rocks"—a conclusion favouring their secondary, and consequently their methylotic origin.

(M.) "Some crystalline limestones are simply mineralised," such as carrarite; though rocks closely related to them—viz., "Dolomites have undergone methylosis." With regard to the latter, however, the authors do not accept von Buch's theory of dolomitisation in its general application. Admitting various kinds of this phenomenon, they conceive the change in certain well-known cases has been effected by the action of the magnesian constituents of sea-water on subjacent beds of limestone; for example, during the closing portion of the Triassic period, as strongly supported by geological evidences, determined by Ramsay and others, the seas in certain European regions became dried up or reduced; and their water, loaded with magnesian salts, sank through the subjacent sandstones and marls into the Permian limestones, thus converting them into dolomites. Irish corroborative cases are mentioned. The dolomites of the Tyrol are held to have originated in the same way; but it is admitted to be probable that the predazzite of the Canzacola Mountain, Val di Fassa, was dolomite that became hydrated by the heated wazer which accompanied the eruption of the immediately adjacent and overlying monzonite. "Serpentinisation effected in deposits without the intervention of mineralisation" is admitted in the production of the magneso-argillite at Vallecas, near Madrid, also of that in the Paris Basin, and other localities; for Sullivan and O'Reilly have shown that it was originally a non-magnesian deposit.

The authors conclude by treating of (N) "The chronogeological range of ophites, &c., and the age of their methylosis."

Offering merely possible suggestions as to the age in which this phenomenon took place in what may be regarded as the oldest ophites (as the subject is beset with considerable difficulties), instances referable to secondary periods, as the dolomites and serpentine rocks of the Tyrol, &c., are briefly noticed; but they refer more confidently to the methylosed euphotides, &c., of Northern and Central Italy, which, having burst through cretaceous limestone (alberese), eocene sandstones and schists, have incontestably produced gabbro verde during late tertiary ages. Moreover, it would appear from the discoveries of Achiardi, that argillaceous schists, in Tuscany, are now being serpentinised by the action of magnesiated water. And, taking the wide range of evidences which have been adduced into consideration, it can scarcely be doubted that the same process is still in operation in deep-seated rocks, permeated by heated waters.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 2.—On the course of formation of residual charge in Leyden jars, with constant difference of potential of the coatings, by W. Giese.—On a relation between pressure, temperature, and density of the saturated vapours of water and some other liquids, by A. Winkelmann.—On Newton's dust-rings, by K. Exner.—Remarks on the electrodynamic fundamental laws of Clausius, Riemann, and Weber, by J. Fröhlich.—General theory of the damping exercised by a multiplier on a magnet, by K. Schering.—Chemical monography of the mica group, by C. Rammelsberg.—Modulus of elasticity of ice, by L. Reusch.—The cross-pendulum, an apparatus for graphic representation of curves of vibration, by P. Schönemann.

Gegenbaur's Morphologisches Jahrbuch, vol. vi. part 1, 1880.—A. Rauber, continuation of first section of his treatise on transformations and their causes in the development of vertebrata (pp. 1-48).—G. Born, postscript to former papers on the carpus and tarsus in amphibia and reptiles, plate 1 (pp. 49-78).—W. Geisbrecht, histology of teeth in echinoids, plates 2-5 (pp. 79-105).—Leo Gerlach, a case of tail-formation in a human embryo, with careful histological drawings, showing an indubitable notochord, plate 6 (pp. 106-124).—M. von Davidoff, on the skeleton of the hind-limbs of holostean ganoids and physostomous teleosteans.

THE *Bulletin de l'Académie Royale des Sciences de Belgique*, No. 12, 1879.—On the variations of the specific heat of carbonic acid at high temperatures, by M. Valerius.—Red spot observed on the planet Jupiter during the oppositions of 1878 and 1879, by M. Niesten.—Denominations given to the spots of the planet Mars, by M. Terby.—Method for determining all the ordinary singularities of a locus defined by k algebraic equations containing $k - 1$ arbitrary parameters, by M. Saltel.—The classification of birds since Linnæus, by M. de Selys Longchamps.—The development of the vegetable kingdom in geological times, by M. Gilkinet.—Jury report on the sixth period of quinquennial competition in the mathematical and physical sciences.

No. 1, 1880.—Existence of a double apparatus and of two sanguineous liquids in Arthropoda, by M. van Beneden (sealed packet).—Remarks on the existence of evolution in curves of the third order and fourth class, by Prof. Weyr.—Description of an isochronous elliptic governor, the speed of whose action can be varied at will, by M. van Rysselberghe.

Archives des Sciences physiques et naturelles, February 15.—Swiss geological review for 1879, by M. E. Favre.—On the time required for surveys of the heavens made with different magnifying powers of the telescope, by M. Thury.—On the constitution of naphtaline and of its derivatives, by MM. Reverdin and Nölting.—Directive ideas for the history of the vegetable kingdom since the tertiary epoch, by Dr. Engler.—Variations of the magnetic declination deduced from regular observations at Moncalieri, in the period 1870-71, by Père Denza.—A series of researches on the pelagic fauna of the lakes of Tessin and of Italy, by Dr. Pavesi.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xiii. fasc. i.—The *mal nero* and the phylloxera at Valmodiera, by S. Trevisan.—Congenital syphilis by direct paternal influence, &c., by Prof. Scarenzio.—On new facts proving the ability of ascarides to perforate unaltered membranes within the abdomen, by Prof. Sangalli.—Contribution to the histology of the voluntary muscles, by Prof. Golgi.

Cosmos, February.—Prof. Dr. Fritz Schultze, on the history of the origin of the conception of soul.—Dr. C. Forsyth Major, on quaternary horses (translated from *Archivio per l'Antropologia*, 1879), A. W. Buckland.

THE *Atti della R. Accademia dei Lincei*, January.—On the chemical composition of the soil of the serpentine of Tuscany, by S. Cossa.—On the cranium of a crocodile discovered in the eocene strata of Veronese, by Baron de Zigno.—Revindication on some correlations between the thermal and other physical properties of bodies, by S. Cantoni.

THE *Revue Internationale des Sciences biologiques*, February.—M. Vulpian, physiological study of poisons, No. 3.—On jaborandi (conclusion).—M. Debierre, on the origin and the evolution of societies, and of the civilisation following contemporary science. Notices of scientific works; scientific societies; book notices.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, March 18.—Prof. Allman, F.R.S., president, in the chair.—The President said that before entering on the ordinary business of the meeting it became his melancholy duty to announce the death of Prof. Thos. Bell at the age of eighty-seven. Prof. Bell was the oldest Fellow of the Society, having been elected into it in the year 1815. He had held the presidential chair for many years, and under his judicious and able guidance the Society had marvellously advanced in prosperity.

He was a distinguished zoologist, and by his researches had largely advanced our knowledge of the fauna of the British Isles. His labours have left their mark on the zoology of Britain, and it is hard to say who can take his place in the department of natural history, in which he had shown himself so loving and conscientious an observer. He was known personally to many here present, and by reputation to all of us, and the meeting will receive with sorrow the sad announcement that he has his place no longer among the Fellows.—Mr. Thos. Christy exhibited a collection of dried flowers from Western Australia, made by Mrs. Bunbury. She observes that the once common native flowers are becoming rapidly scarce in the pasture land of the colony, and that it is even difficult to propagate them by culture.—There was also shown for Mr. J. T. Carrington a male and female example of the Northern Stone Crab (*Lithodes arctica*), which had lived in the Westminster Aquarium. The peculiar asymmetry of the abdominal segments in the female was adverted to, and from this and other reasons an affinity with the Hermit Crabs pointed out.—The Secretary read a communication from Mr. H. M. Brewer, of Wanganui Acclimatisation Society, on the indigenous timber and on plants introduced into New Zealand. Among the former, "Manaka" (*Leptospermum ericoides*) is useful for spokes, tool handles, &c.; "Korohai" (*Sophora tetraptera*) forms admirable material for carving, &c.; "Totara" (*Podocarpa totara*) is most durable for piles, railway sleepers, &c.; red birch (*Fagus fusca*), on account of its strength, is well adapted for beams and framework; and the "Matai" (*P. spicata*) is so durable that a prostrate tree found in damp bush and supposed to have lain there for a couple of centuries still retained its soundness when cut up. Of plants introduced quite a host thrive out of doors. Among others the coral tree (*Erythrina caffra*), with its brilliant scarlet flowers. *Fourcroyia gigantea*, which produces a fine fibre and grows well without any cultivation on the waste clay hills; also *F. flavoviridis*, another fibre-yielding plant. *Chamærops excelsa*, *C. humilis*, *Musa textilis*, and *M. sapientum*, equally thrive, the banana ripening good fruit. *Broussonetia papyrifera*, from which paper is made in Japan. The pomegranate (*Punica granatum*) and the olive (*Olea europæa*) hereafter are likely to become important as commercial products. The Natal plum (*Arduina grandiflora*), the fig (*Ficus carica*), custard-apple (*Anona muricata*), *Eriobotrya japonica*, ginger (*Zingiber officinalis*), the tallow tree (*Stillingia sebifera*), cinnamon, camphor, orange, lemon, and citrons, besides many other sub-tropical plants, afford sufficient proof of the mildness of the climate and capabilities of the country ultimately to depend on its own resources. Of araucarias and pines a great number of introduced species have thriven well, some only requiring a little shelter at first. Oaks, elms, poplars, &c., all take naturally to the New Zealand soil, but sufficient has been said to indicate the great variety of flora indigenous and introduced into this flourishing though distant colony.—A paper by Prof. J. O. Westwood, on a supposed polymorphic butterfly from India, was also read by the Secretary for the author. The conclusions arrived at are: (1) of *Papilio Castor* being males of a species whose females have not yet been discovered; (2) that the typical *P. Pollux* are females of which the male with rounded hind wings having a diffused row of markings has yet to be discovered; and (3) that the coloured figures given by the author represent the two sexes of a dimorphic form of the species.

Physical Society, March 14.—Dr. Huggins in the chair.—New members—Prof. Minchin, Mr. Hulme, Mr. A. Stroh, Prof. D. E. Hughes, Lieut. Wingfield, Mr. J. Macfarlane Gray. Mr. W. Chandler Roberts, F.R.S., drew attention to an explanation which has recently been suggested by Dr. Van Riemsdijk of Utrecht to account for the "flashing" which attends the solidification of cupelled buttons of gold and silver. He showed experimentally that at the point of solidification the metals emit a flash of greenish light, which Dr. Riemsdijk thinks is probably due to the globules being really in what is known as the superfused or surfused state; that is they fall some degrees below their points of solidification without setting, and the change from the liquid state is accompanied by the liberation of the latent heat of fusion, which again heats the globule and renders it incandescent. In an attempt to obtain inductions as to the state of certain fused metals by the aid of the induction balance, Mr. Roberts was able to show that the resistance of silver in the molten state is far greater than when the metal is solid, and on the other hand he had confirmed De La Rue's statement that the resistance of molten bismuth is less than that of the solid metal, and he also obtained evidence that bismuth in cooling may be made to pass through a superfused state similar to that which occurs in the buttons of gold. Mr. N. Lockyer thought the greenish tint of the light might be due to a solid film on the surface of the globule.—The Secretary then read a paper by Prof. W. F. Barrett, announcing that he had found a current of electricity to be generated by the rotation of the prepared chalk cylinder in the receiver of the Edison telephone. When the platinum stylus which rubs on the cylinder is connected through a galvanometer to the brass axle on which the cylinder is mounted, a current is observed whose E.M.F. is over $\frac{1}{4}$ volt. This current falls off as the rotation continues, owing, Prof. Barrett assumes, to the electrification of the surface of the chalk. Prof. Barrett attributes the current to friction solely, and seeks to account for the receiving action of Edison's telephone by this frictional current being modified by the transmitted currents, and not by the electrolytic action to which it is usually ascribed. These experiments originated with a suggestion of Prof. Sylvanus Thompson that the Edison receiver might act as a transmitter. Prof. Barrett had at length succeeded in making it act in this capacity by means of the frictional current.—Mr. Shelford Bidwell exhibited some experiments bearing on Prof. Barrett's observations, which tended to show that the source of the current in the Edison receiver was due to the fact that a voltaic element is formed by the platinum rubbing-point, the brass axle, and the prepared chalk. This chalk is usually impregnated with phosphate of soda, or, as in the author's experiments, with caustic potash and acetate of mercury. The cylinder seems to be dry, but is probably moist; wetting it greatly increases the current. There is a very feeble current when no motion of the cylinder takes place, but rotation of the cylinder greatly increases it. Platinum is electro-negative to brass, and hence the positive current flows from the platinum to the brass through the galvanometer. This was demonstrated by substituting zinc for platinum, when the current was reversed and flowed from the brass to the zinc, owing to the fact that brass is electro-negative to zinc. Mr. Bidwell showed, by means of a simple pile of copper and tin foil separated by a moist cloth or paper, that the motion of the tin across the paper increased the current of the cell. In the case of a cell made of *two* tin plates separated by moist paper, the current was set up by moving one plate over the other. The plate which moved relatively to the paper was always electro-negative to the other. Mr. Bidwell also showed by a simple experiment that the action of Edison's receiver was electrolytic. He caused the mere passage of a current to lessen the friction of a metal strap on a drum covered with moist paper, and thereby released the drum by the evolution of hydrogen. Prof. Ayrton pointed out that the rubbing action in these experiments assisted the current by bringing up fresh electrolytic matter, a fact which had been taken advantage of in the construction of several batteries. Prof. Adams remarked that this action did not seem to explain how the current was *reversed* in the cell composed of *two* tinfoil plates.—Prof. Guthrie then demonstrated by experiment a curious anomaly in frictional electricity. When flannel is rubbed with ebonite the flannel is + electrified; when ebonite is rubbed with glass the ebonite is + electrified; and we should therefore expect that when flannel is rubbed with glass the flannel would be still more + electrified; but instead of that it is really feebly negative. Perhaps the fact that the heat of friction enters into one substance more than the other affected such results.—The Secretary then read a note from Mr. Ridout, stating that he had succeeded in Dr. Guthrie's funnel experiment mentioned at last meeting, and by means of a stream of water flowing out of a glass funnel had attracted a glass cone towards the mouth of the funnel. The angle of the cone was greater than the angle of the funnel.

Victoria Institute, March 11.—Prof. Hughes, of Cambridge, read a paper upon the movements of elevation and depression in the British Isles, in which he continued his argument against the existence of preglacial man.

EDINBURGH

Royal Society, March 1.—Prof. Geikie in the chair.—Sir William Thomson communicated to the Society his new method for measuring temperatures by means of "steam-pressure thermometers of sulphurous acid, water, and mercury"—a method which will be found fully described in the article "Heat," in the forthcoming volume of the "Encyclopædia Britannica." The system here proposed is essentially a *manometric* one as opposed to the ordinary *volumetric* one. Any given temperature is definitely measured by the pressure exerted by the *steam* of a convenient liquid which is kept at the required temperature, where by steam is meant vapour in presence of its liquid. The range of temperature through which sulphurous acid can be so employed, with a moderate column of mercury (the *manometric column*) to measure by its height the pressure exerted, is from $-40°$ C. to $+20°$ C. Below this inferior limit carbonic acid may be substituted, and above the superior limit water is eminently suitable, and can be made to stand a temperature of 140° C. For still higher temperatures the steam-pressure mercury thermometer is required, a water manometric column being used for temperatures below 280°, and a mercury manometric column for temperatures above that limit and below 520°. The water manometric column is necessary for the lower range, so as to give the thermometer sufficient sensibility for registering small increments of temperature throughout that range. A sulphurous acid cryophorus was also exhibited, its structure being the same as the differential steam-pressure sulphurous acid thermometer, which is simply a U-tube closed at both ends and filled with sulphurous acid in the liquid and gaseous states. This instrument was the type upon which the steam-pressure water thermometer and the steam-pressure mercury thermometer for the highest range were constructed.—Sir W. Thomson also communicated a paper on the vibrations of a columnar vortex, in which he proved that the velocity of propagation of a longitudinal wave along an infinitely long vortex column was about one-third the velocity of the surface of the column in its undisturbed state. He also discussed the case of transverse vibrations, and pointed out the importance of such investigations as probably throwing some light upon the nature of the sudden gusts which accompany great storms.—Prof. Turner read a paper on the structure of the comb-like appendages and teeth of the basking shark. These comb-like appendages, though differing remarkably in many ways from whale-bone, seemed to serve a very similar function.—Sir Wyville Thomson communicated a preliminary report, by Mr. Herdman, on the *Ascidiæ* of the *Challenger* Expedition, from which it appeared that of the sixteen new species discovered by the *Challenger*, only two had been previously known.—Prof. Tait laid before the Society a few notes regarding his application of rotatory polarisation to the determination of the position of bright lines in feeble spectra.

Boston, U.S.A.

American Academy of Arts and Sciences, March 10.—Charles Francis Adams in the chair.—Prof. Edward C. Pickering read a paper on Huggins's recent photographs of the spectra of stars, and gave a formula based on the molecular constitution of matter, which apparently explained the peculiar grouping of lines observed by Huggins.—Mr. Albert A. Michelson, of the United States Navy, explained a plan for obtaining the velocity of the solar system through space. He proposes to measure the velocity of light by a method which obviates the necessity of having the ray of light pass back and forth over the same path, and by the employment of the revolving mirrors, which are maintained at the same speed of revolution, the velocity of light can be obtained in the direction of the movement of the earth through space and in the opposite direction. Mr. Michelson is about to undertake experiments to determine the question of the movement of the solar system.—Prof. J. P. Cooke, of Harvard University, gave the results of various methods which have fully confirmed his value obtained for the atomic weight of antimony.

Paris

Academy of Sciences, March 22.—M. Ed. Becquerel in the chair.—The following papers were read:—On the origin of the solar system, by M. Faye.—On some applications of elliptic functions, by M. Hermite.—On the compensation of temperatures in chronometers, by Mr. Phillips.—On the tritoxide of silver, by M. Berthelot.—Observations on the decomposition of permanganate of potash by oxygenated water, by M. Berthelot. He is led to the hypothesis of a tritoxide of hydrogen (HO_3) resulting from oxidation of oxygenated water by the permanganate.—On electric regulation of the hour in Paris, by M. Tresca. The system comprises (1) a certain number of horary centres distributed on two telegraphic systems; they are good clocks, with action regularised every second; (2) the clocks of the town kept in their present state, but true in time. Of the former, six have been in action since January 3; and six others, on a distinct system, are to be set up.—Report to the Academy on the results obtained during the voyage of the *Magicienne*, for observation of the transit of Mercury, by Admiral Serres. This includes information about transport of time, differences of longitude in South America, observations on magnetism, measurement of the force and direction of winds, the transit of Mercury, description of an electric log, &c.—On the curves defined by a differential equation, by M. Poincaré.—On the integrals of algebraic functions, by M. Pellet.—On a class of functions of several variables drawn from inversion of integrals of solutions of linear differential equations, the coefficients of which are rational functions, by M. Fuchs.—Analysis of luminous phenomena produced by electric discharges in rarefied gases, by M. Fernet. The discharges in a large vertical tube were viewed by reflection in a rotating mirror behind a slit in a screen. The peculiar appearances of the bright curves occurring between the poles is described.—On the thermal laws of electric sparks produced by ordinary, incomplete, and partial discharges of condensers, by M. Villari.—On a case of remanent polarity of steel opposite to that of the magnetising helix which produces it, by M. Righi. Theory led him to believe that with a series of bars of the same steel and diameter, but decreasing lengths, a certain length would be reached which would not give magnetisation, while, with less length, a remanent polarity would be got, opposite to that of the coil. He states how he realised the latter.—On the photography of the solar spectrum, by M. Conche. His method is long exposure of bromised gelatine plates.—On the density of iodine at high temperatures, by MM. Crafts and Meyer.—On a mode of production of acetal, by MM. Engel and Girard.—Specific heats of solutions of potash and of soda, by M. Hemmerl.—On the alkalies of pomegranate, by M. Tanret.—Artificial production of a leucotephrite identical with the crystalline lavas of Vesuvius and La Somma; nascent crystalline forms of leucite and nepheline, by MM. Fouqué and Levy.—Artificial reproduction of spinel and corundum, by M. Meunier. Chloride of aluminium, steam, and metallic magnesium (or zinc) were brought together in a heated tube.—On the normal presence of copper in plants which live on rocks of the primordial formation, by M. Dieulafait.—Researches on the vaso-motor innervation, the circulation of the liver and of the abdominal muscles, by M. Laffont.—On the anatomical character of the blood in phlegmasias, by M. Hayem.—On the godrooned cells of the intravaginal hyaline system of the nerves of Solipedes, by M. Renant.—On the nervous system of *Idothea entomon* (an isopod crustacean), by M. Brandt.—On the caducity of the hooks, and even of the scolex in Tænias, by M. Mégnin.—M. Larrey presented, from M. da Cunha Bellem, a Portuguese work, entitled "Medical Life on the Battle-field," and gave an analysis of it.

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