THURSDAY, APRIL 21, 1892.

THE YAHGAN.

Mission Scientifique de Cap Horn. Tome VII. "Anthropologie, Ethnographie." Par P. Hyades et J. Deniker. (Paris: Gauthier-Villars et Fils, 1891.)

THIS volume contains the record of an important part of the work done by a French scientific Expedition which spent a year at Tierra del Fuego. The Expedition was organized in June 1882 by a Commission appointed by the Academy of Sciences; and in November 1883, after its return to France, it presented to the Academy its preliminary reports. Since the latter date, its results have been embodied in a series of volumes, prepared under the control of the Commission, and published under the auspices of the Ministries of Marine and Public Instruction. The first volume contains a history of the voyage, by the late L. F. Martial, the Commander of the *Romanche*, in which the Expedition sailed. The second volume, by L. Lephay, is devoted to meteorology; the third, by F. O. Le Cannellier, to terrestrial magnetism; the fourth, by P. Hyades, to geology; the fifth, by Hariot, Petit, Bescherelle, Massalongo, and Franchet, to botany. It was originally intended that zoology should also be dealt with in a single volume; but the material obtained by the Expedition was so rich and of so much scientific importance that three volumes were found to be necessary. The present volume, nominally the seventh, is really the ninth, and completes the series. Although Dr. Deniker is associated with Dr. Hyades as one of the authors of this work, he did not accompany the Expedition. He has rendered, however, important service in the working-up of the anthropological and ethnographical data brought back from Cape Horn.

The book is one in which serious students of anthropology will find much to interest them. It offers a great mass of original observations, made, as Dr. Hyades explains, without any preconceived idea; and they are not only arranged methodically, but set forth in a style of admirable simplicity and clearness. The volume is also enriched with numerous plates, some of which are finely-executed heliogravures.

The Fuegians are divided into three groups—the Ona, the Alakalouf, and the Yahgan. The Ona inhabit the great island of Tierra del Fuego from the southern coast of the Strait of Magellan to near the northern shore of Beagle Channel. They are probably a branch of the Patagonians, and the Expedition had no opportunity of seeing any of them. The islands and a part of the mainland to the west of the Ona are inhabited by the Alakalouf, to the south of whom are the Yahgan. These two peoples speak different languages, but seem to have essentially the same racial characteristics. It was among the Yahgan that Dr. Hyades carried on his studies, and to them the volume almost wholly relates.

The Expedition brought back the body of a Yahgan who died while the *Romanche* was at Orange Bay, and who during his lifetime had been subjected to various careful measurements. They also brought the skeleton of a woman and the skeletons of five children; three skulls (two of men, one of a woman); two incomplete skeletons, and various detached bones. These remains are made the subject of a thorough anatomical study which is the more valuable because the results at which the authors have arrived are compared with those reached by previous investigators. There is also an elaborate chapter on morphological characters, setting forth various classes of facts noted in the course of accurate observation of the physical qualities of living persons. The Yahgan are mesocephalic, the men having a tendency to be dolichocephalic, the women to be brachycephalic. Most of the South American aborigines are decidedly brachycephalic; but here and there tribes are found whose skulls resemble those of the Yahgan. This is especially true of the Botocudos, who are also like the Yahgan in being rather below the average height of other natives, and in the form of the face, the nose, and the mouth. Various ancient skulls which have been found at Lagoa Santa in Brazil, at Pontimelo in the Argentine Republic, and elsewhere, have the same general structure as those of the Botocudos and the Yahgan. The authors therefore conclude that these and some other tribes are more or less pure remnants of a race which at one time occupied the greater part of South America, and were displaced by brachycephalic peoples, with whom the survivors to some extent mingled. Of these brachycephalic peoples, the Patagonians alone are very tall, the rest being of moderate height. All, however, whether tall or short, are of a different physical type from the Yahgan.

The Yahgan live chiefly on fish and mollusks. They also eat any kind of bird they can catch, and are fond of the flesh of the whale, the seal, and the otter. When pressed with hunger, they will eat the fox, but never dogs or rats, the latter being held in abhorrence. Fishing is left entirely to the women, while the men hunt. They have splendid powers of digestion, and assimilate their food so readily that they sometimes become fat in the course of a single day. Their huts are made of branches or of the trunks of trees, the interstices being imperfectly filled up with moss or bark, with fragments of canoes or with sealskin. These slight dwellings are put together in a few hours, and as they admit the wind freely, the air in them is generally fresh. In the centre is a fire, around which the inmates sleep at night, and at other times, when they have nothing else to do, sit talking and laughing. The Yahgan lose early the attributes of youth, but often retain their vigour to a great age. They are very courageous, and enjoy games which test their physical strength.

Among the women intimate friendships are not uncommon, but men generally form attachments to one another only if they have been brought up together. Children are tenderly cared for by their parents, who in return are treated by them with affection and deference. Some men have two or more wives, but monogamy is the rule. The girls do not choose their own husbands; they must take those whom their parents provide for them. Before marriage they are allowed great liberty, but when they become wives they have less freedom, the husbands being extremely jealous, and being supported by public opinion in punishing severely any departure from conjugal duty. This account differs from that of some other observers, but Dr. Hyades is confident that his statements on the subject are strictly accurate. Both girls and married women are remarkable for the modesty of their demeanour, and expect to be treated respectfully.

When the Yahgan approach a strange vessel in their canoes, they might be taken for abject beggars; but on shore visitors obtain a different impression. There the natives display perfect independence, and they readily take offence at anything which they interpret as a slight. They are far from having a community of goods, every man claiming as his own that which he himself has found or made; but they are of a generous disposition, and like to share their pleasures with others. That they have a sense of right and wrong Dr. Hyades does not doubt, but their moral distinctions are not always very sharply drawn. They are accomplished liars, and the only disadvantage of a lie seems to them to be that the truth is sometimes apt to be found out. A man convicted of theft, however, will show that he is ashamed of his deed; and murder is punished with death. The Yahgan have often been accused of cannibalism, but Dr. Hyades agrees with Mr. Bridges, who knows them thoroughly, in regarding this charge as utterly without foundation.

They can occupy themselves continuously for a considerable time with any employment to which they are accustomed, such as the making of a harpoon; but it is hard for them to devote attention to anything with which they are not familiar. When questioned on any subject, they soon become confused, and give answers at random. They do not divide time or count beyond three, and have remarkably short memories. But they are good observers of the signs of the weather, of plants, and of animals; and they have an extraordinary power of mimicking attitudes, gestures, and cries, although they have no such faculty of imitation as leads to the production of new instruments, utensils, or other useful objects. They are wholly unable to make anything, however simple, after a given model. They often have dreams, but do not generally appear to attach to them any significance. They have neither poetry, nor history, nor traditions; and Dr. Hyades asserts that the members of the Expedition never saw among them the faintest trace of religious ideas or sentiments. Those of them who are directly under the influence of English missionaries have learned to live regular lives, but have lost many aptitudes possessed by the savage Yahgan; and they easily fall victims to various forms of disease which have been imported with civilization.

The language of the Yahgan is dealt with in a long and most instructive chapter; and interesting details are given as to the occupations of the people, their domestic customs, and many other subjects. Of the plates, to which we have already referred, we need only say that they alone would have sufficed to make the work an invaluable contribution to ethnographical and anthropological science.

QUANTITATIVE ANALYSIS.

Quantitative Chemical Analysis. By Frank Clowes, D.Sc. Lond., and J. Bernard Coleman. Pp. 309. (London: J. and A. Churchill, 1891.)

THIS book embodies the material usually included in a complete course of elementary instruction in quantitative analysis. It is divided into five parts. Part I. treats of the balance, the determination of physical constants, the purification of substances, and preliminary analytical processes generally. The more important simple gravimetric estimations are grouped in Part II.; and are followed, in Part III., by descriptions of the methods and the more common determinations comprised under volumetric analysis. In Part IV. are classed more complex exercises, involving both gravimetric and volumetric processes. Here are to be found analyses of ores, technical products, fuel, articles of food and drink, including complete analyses of milk, butter, sugar, and partial analyses of wine, beer, and tea. The valuations of tannins and soaps are next given, and the part concludes with a section on the typical methods of organic analysis. Part V. is devoted to a description of the ordinary methods of technical gas analysis.

The above brief summary of contents will show that the aim of the volume is eminently practical; and with regard to the purely chemical sections little but praise can be expressed, both at the general and detailed treatment of the subject. All the more important estimations have been included, and the practical points to be observed in accurate work are clearly stated. A noteworthy feature, and one especially helpful to the student, is the brief statement of the principle of each estimation, in a sentence or two, before the detailed process is described. The accounts of food and gas analysis are both useful and interesting, and are seldom met with in manuals of this kind.

There can be no doubt but the book will be a serviceable guide to the student, and aid to the teacher.

One or two minor points, however, seem worthy of criticism. It is stated in the preface that, in order to economize space, "unnecessary theoretical matter" has been omitted, and apparently this idea has been carried too far. For example, it is but just to tell the student why in estimating sulphur as barium sulphate, nitric acid is first expelled. Knowledge of a similar kind, more especially in the physical portions of the book, is occasionally left out, and descriptions are thus rendered more or less empirical.

If it is considered necessary to give methods for determining specific gravities, boiling-points, &c., in a work of this kind, the accounts should be modern, and the accuracy aimed at should be comparable with that attained in the chemical sections. Absolute specific gravity—or shortly, specific gravity—as used in the book, with no temperatures of comparison attached, is now generally taken to be the weight of unit volume; such a definition is not hinted at, and none of the methods given serve to obtain the absolute specific gravity. The time-honoured but obsolete pyknometer, closed by a perforated stopper, still finds a place, and the original Sprengel pyknometer is figured, although it might well be replaced by Perkin's more generally useful modification.

With regard to the estimations of boiling-point, it should have been clearly stated that to take the barometric pressure was a necessary part of any trustworthy determination. In correcting for the exposed column of the thermometer, one of the more recent coefficients might have been given in place of the oldest and least satisfactory. What is supposed to be the mean temperature of the cooled column is erroneously stated to be the temperature of the air. A little more detail, especially in connection with the suspension of the tube in Chapman Jones's boiling-point apparatus, would have been advisable.

Bunsen's method of calibrating a eudiometer is given, but none of the methods for utilizing the results to obtain the volume at any point is mentioned.

The indiscriminate use of both English and French units throughout the book does not seem to have any advantage; indeed, to give the dimensions of a tube as "1 millimetre in bore, . . . 8 inches in length," may be practical enough, but it is hardly scientific.

The meaning of expressions such as "water . . . drawn back . . . by the partial vacuum," "liquid" of a given "gravity," "ammonia condensed in hydrochloric acid," "the tension of aqueous vapour," might be conveyed in language free from objection.

The book is almost free from typographical errors; only two were noticed. On p. 227, cadmium sulphate is printed for cadmium sulphide, and the letter (*a*) should be replaced by (*b*) at the foot of p. 349.

The table of contents, referring to page and paragraph, and the index are particularly complete. A useful appendix giving results of typical analysis, constants for calculating results, &c., is added, and a list of works of reference is given in the introductions to the different parts. The relative importance of different estimations is indicated by difference in the type, and cross-references are frequently introduced. These points alone go a long way to indicate the pains taken by the authors to meet the wants of the student. J. W. R.

ASTRONOMY.

Elementary Mathematical Astronomy. By C. W. C. Barlow and G. H. Bryan. "University Correspondence College Tutorial Series." (London: W. B. Clive and Co., 1892)

THE task of writing a book on astronomy which shall enable a beginner to grasp all the fundamental principles and methods without entering into elaborate details of mathematics is by no means a light one. What the authors have done, and we may say very successfully too, has been to strike a mean between the numerous non-mathematical works and those which involve high mathematics, using just enough to enable the reader, if he wishes, to proceed to the more advanced treatises.

To simplify matters further, all investigations which require a knowledge of the elements of dynamics have been collated together at the end under the title of dynamical astronomy, thus separating them from those of descriptive astronomy, which only needs elementary geometry, trigonometry, and algebra. Some of the chief properties of the ellipse which are of astronomical importance are contained in the appendix, while for the properties of the sphere an introductory chapter has been inserted.

This summary will give an idea of the range over which the student will have to extend his mathematical abilities, and after all it is by no means an extensive one, considering the ground which this work covers.

In the chapter on the Observatory a very good account is given of the transit circle and its accompanying errors; but of course, without spherical trigonometry, many points of great importance with regard to the reduction of observations have had to be omitted. The chapters on the earth, sun's apparent motion and time, all contain lucid and concise explanations, which are well illustrated by figures showing the great circles involved. Many interesting problems are worked out in the chapters on the moon and eclipses, while that on the planets contains a good account of the stationary points in their apparent motion.

"The Distances of the Sun and Stars" is the title of the chapter that concludes the non-dynamical section, and in it the interesting problems on finding the parallax of the sun are discussed, together with the various results that ensue from the aberration of light.

Coming now to the second part of the book, the rotation of the earth and the resulting consequences are first dealt with, in which the proofs of the former are clearly described; while many problems relating to pendulum oscillations, variation of gravity at different places, &c., are fully expounded. The following two and concluding chapters are devoted wholly to the laws of universal gravitation, and to the multiple applications to which they are subjected. These chapters are perhaps the best in the volume, and contain, of course, some most important problems, such as the determination of the density of the earth, precession, tides, &c.

The examples and examination-papers, which are by no means few in number, will be found to be both original and well selected; and this is really important, for a sound knowledge of this subject can be obtained only by the continual practice of working them out.

In conclusion, we may state that altogether the work is one that is sure to find favour with students of astronomy, and will be found useful to those for whom it is especially intended. This is by no means the first volume that we have received which is published in this Tutorial Series, and the present work is a good example of the excellent text-books of which it is composed.

OUR BOOK SHELF.

Practical Fruit Culture. By J. Cheal, F.R.H.S., Member of Fruit Committee, Royal Horticultural Society, &c. Illustrated. (London: George Bell and Sons, 1892.)

WITHIN the last few years farmers and others have often been advised to take to the cultivation of fruit, and there can be little doubt that much of the profit connected with fruit-growing—now absorbed by foreign traders—might, under certain conditions, be kept in the hands of our own people. The most important of these conditions is that persons who think of devoting attention to fruit culture shall obtain sound information about the work they propose to undertake, and that at all the later stages of their enterprise they shall act under the guidance of trustworthy authorities. In the present little volume, which forms one of Bell's "Agricultural Series," Mr. Cheal has brought together, and carefully arranged, a great many facts which cannot fail to be of service to intelligent fruit-growers. He begins with a chapter on the general prospects of culture for profit. Then come chapters on the selection of soil and situation, the preparation of the ground, what to plant, planting, pruning, cost and returns per acre, the renovating of old orchards, gathering, packing and distributing, storing and preserving, grafting, budding, and stocks. These chapters form the first part of the book. The second part consists of counsels on various subjects to private growers, and in the third the author deals with insect pests and disease. The work is essentially practical, and will tend to stimulate the development of what ought to become a more and more important British industry.

Blowpipe Analysis. By J. Landauer. Authorized English Edition. By James Taylor. Second Edition. (London: Macmillan and Co., 1892.)

Dr. Landauer's work presents so much sound knowledge in so compact a form that the fact of the English version of it having reached a second edition is in no way surprising. The text, we are informed in the preface, has been completely revised, and new methods of approved value have been incorporated. The author and the translator call especial attention to the fact that some additional details of manipulation will be found of value by readers who are working up the subject without a teacher.

LETTERS TO THE EDITOR.

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

Prehistory of Egypt.

The evidences of denudation are so striking in the ravines of the Egyptian deserts, that I make the following notes, hoping that some trained geologist will be induced to do more for the subject. The successive periods which I have noted are as follow:—

(1) *Rainfall*, before much excavation of the Nile bed; producing an enormous river with rolled gravels and blocks up to 3 feet long. It is unlikely that this was merely a beach, as the gravels extend for many miles north and south; nor would it be estuarine, as the flow must have been rapid. The only parts of these beds that I have seen are on the tops of the hills dividing the Nile from the Fayum, which are entirely composed of these gravels. The great mass of these beds has been denuded away by the later Nile and rainfall, leaving these ridges 200–300 feet above the present Nile.

(2) *Rainfall and elevation.* All over the desert plateau of limestone, the strata of which are usually horizontal, there are sharp depressions and faults. These are usually of small area, a quarter to half a mile across, with a drop of over 200 feet. The strata are at the same level, and horizontal, on the opposite sides of these depressions, but are steeply curved and faulted down into the hollows. The only cause seems to be the falling in of immense caverns in the limestone, for there is no trace of thrust or upward folding anywhere. Such caverns must have been produced by great rainfall, and high elevation to allow of the water draining off at so low a level, below that of the present Nile.

(3) *Disturbances.* It is impossible to suppose that the great gravel beds of the Nile in period (1) were deposited along the steep edge of a basin 400–500 feet deeper; hence the deep Fayum basin must have been depressed (as it can scarcely have been eroded) subsequently to the period (1), and probably during the same disturbances which shook down the strata into the caverns of (2).

(4) *Great rainfall and elevation continued*, during which the present Nile bed has been eroded, and the ravines graved out in its sides, reaching back for many miles through solid rock. This was subsequent to (3), as the ravines were partly determined by the subsidences, and have cut through them. This was a long period to allow of 200–300 feet of rock to be cut out of the Nile bed. The elevation was probably the same as in (3), as the rock bed of the Nile is at a great depth under deposits in Lower Egypt. The rainfall was violent, as the sides of narrow ridges of rock, which cannot have collected much, are grooved into deep flutings all along; and the waterfalls from basins of only one or two square miles, are wide and steeply cut.

(5) *Rainfall, and depression forming an estuary.* Up to about 300 feet above the present Nile, remains of perfectly horizontal beds of *débris* may be found clinging to the sides of the ravines, which must be subaqueous deposits. In front of each of the ravines are foot-hills of *débris*, evidently washed out of the ravines, and deposited in an estuary. There cannot have been much current in the main valley, as these foot-hills extend sometimes two miles outward; yet there was some current, as they are always on the lower side. This appears to be in the human age, from the rolled river palæolith which I found at Esneh, and which cannot have belonged to a later time. These estuarine beds occur as far up as Tel el-Amarna or further.

(6) *Rainfall, gradual and intermittent elevation*, leaving various levels of foot-hills in the estuary. To this belong the chipped flints of the *débris* beds in front of the ravine of the kings at Thebes, as man was probably inhabiting that valley, for these to have been washed out of it. The rainfall continued until the estuary was completely dried, as the watercourses have cut down to the present Nile level. Nile mud began to be brought down and deposited while the water was yet 30 feet above the present, either as a river or estuary.

(7) *Complete desiccation*, throughout the historic age. The roads marked out with stones on the plain at Tel el-Amarna in 1400 B.C. are only destroyed in the very lowest lines of the watercourses. The ancient buildings in Egypt only show the effects of rare storms, and not of continued rain. The mud deposits throughout this age are at an average rate of 4 inches per century in the old bed of the Nile.

The sequence described here seems to be tolerably clear, though much more detail needs to be filled in as yet.

W. M. Flinders Petrie.

Aphanapteryx in the New Zealand Region.

I sent you a short note some weeks ago announcing the discovery of a species of the Mauritian genus *Aphanapteryx*—which I had named *Aphanapteryx hawkinsi*—in the Chatham Islands. I have just returned thence from a visit made expressly for the purpose of searching for further remains of this bird, of which I received at first only the cranium. I have been very fortunate in my search, and have procured several most perfect crania, with tibiæ and femora, which I have no doubt belong to the same bird, as more than once I discovered these bones in the immediate neighbourhood of the crania. The bones have been disinterred from the lower beds of a sandbank facing the shore. Some years ago, a great storm, followed, as I am told, by a tidal wave of great height, broke the Eurybia-protected shore bluff; and now the wind, having carried off the upper bed of light-coloured sand into the lands behind, is continually planing down more and more the brown lower bed in which these bones seem mostly to be entombed. They are in a most perfect state of preservation, and very complete, though deprived of all their animal matter. Of the *Aphanapteryx* crania some are considerably larger and some much smaller than *A. Brœckei*, the larger reaching to within $\frac{1}{20}$ inch of 6 inches from the top of the slender arched upper mandible to the occiput. The tibiæ and femora vary in size corresponding to the differences in the crania; but they present the main characters of the bones figured by M. Milne-Edwards in his "Oiseaux fossiles de la France." It may yet turn out that more than one species of *Aphanapteryx* inhabited the Chatham Islands. It is very singular that, among the thousands of bones that have been collected from different swamps, Maori middens, and caves in various parts of New Zealand, not a single bone of this bird should have come to light. In one refuse heap from a Moriori feast laid bare by the wind on the beach of Petre Bay, I found several specimens of *Aphanapteryx hawkinsi*, along with crania and other bones of ducks, swan, sea-birds, seals, whales, &c. Swan-bones were everywhere very abundant in this brown sand bed; some of them indicating birds equal in size to *Chenopis atrata*, others considerably exceeding it. In one very ancient midden the remains I dug up consisted almost entirely of swan-bones, with the intermixture of only a few duck-bones. The *Aphanapteryx* must, I think, be the wingless bird spoken of by the Morioris as *Mehiriki*, although those to whom the skull has been shown fail to recognize the bird at all. They speak also of another flightless bird by the name of *Mehunui*. This bird, one old and very intelligent Moriori informed me, was the same as the Maoris called *Kakapo*. Mr. Alexander Shand, an old resident in the Chatham Islands, and the sole European living versed in Moriori customs and traditions, and capable of speaking their language with fluency, also confirmed this information, and told me that the *Kakapo* (according to the Morioris) was very abundant in the islands prior to 1836. He himself in the early days had seen their burrows often. I had observed, while collecting, several Psittacine bones, and on learning this fact I felt sure that those I had picked up and packed away must belong to *Stringops*. On my arrival here, however, I find so far that there are no *Kakapo* bones in the collection, the Psittacine bones being the head and beaks of *Nestor notabilis*, the Kea. I have as yet had time to do no more than run through the collection I have brought back; but there appear to be in it several large Ralline tibiæ of species unknown to me. I am looking forward to another opportunity of thoroughly exploring these interesting islands with more time at my disposal than I could afford on this occasion. HENRY O. FORBES.

Canterbury Museum, February 23.

Pigments of Lepidoptera.

A LETTER of mine on the subject of butterfly pigments was published so recently in NATURE (December 31, 1891, p. 197) that I hesitate to ask for further space at the present time. But the appearance of Mr. Perry Coste's articles, together with the tone of some remarks made by him at the close of the last article, lead me to venture upon a few words, partly in criticism of a theory he advances, and partly (though this is less important) in claim of priority, since Mr. Coste does not do me the honour to refer to my work on the subject.

The chief generalization which Mr. Coste bases upon his experiments is that which he terms the "reversion effect,"—that is to say, the production of yellows from reds by the action of acids, and the restoration of the former by neutralization and other means. The theory that he advances to explain these phenomena—namely, that the red body acts as a base, and forms with acids salts which are yellow—is quite untenable. As I have shown (Proceedings of the Chemical Society, June 1889; *vide* NATURE, vol. xl. p. 335), the soluble yellows are themselves acid bodies of quite definite composition. Indeed, as far back as 1871, Prof. Meldola called attention to the fact that the pigment of *G. rhamni* was soluble in water, and showed that its aqueous solution had an acid reaction. Mr. Coste has worked with *D. eucharis*; if he will dissolve the red pigment from the border of the hind wing of this insect *in pure water*, he will find that a *yellow* solution is the result, but that, if the solution be evaporated to dryness, the solid residue of pigment is red once more; showing that there is either the question of hydration to consider, or a weak combination of the yellow acid body with a base, which is dissociated in aqueous solution. At any rate, I have obtained from this red pigment of *eucharis* a silver compound which contains a percentage of metal exactly equal to that from the pigment of *G. rhamni*.

In 1889 I was able to predict possible constitutional formulæ for the acid yellow pigments, and am happy to say that recent careful combustions of their silver salts to a large extent confirm my original ideas. My results will be shortly published *in extenso*.

Mr. Perry Coste's experiments are very useful as forming a method of classifying these lepidopterous pigments; but, if he will forgive me for saying so, they are of far too empirical a nature for any considerations as to the constitution of the bodies to be based upon them. As one who has for many years past spent a large portion of his time and no inconsiderable portion of his substance in obtaining a sufficiency of these pigments for analysis and investigation, Mr. Coste will forgive me if I do not respond to his invitation to leave him "to continue his researches alone." It is hardly well for one investigator to say "hands off" to another, and I shall not imitate Mr. Coste in this matter; but will only express a hope that in his future work he will not confine himself to the immersion of the wings of his insects in strong and destructive reagents.

I have lately been working at the genesis of these pigments in the pupæ, and might say something with regard to the nature of the group which Mr. Coste labels as doubtfully pigmentary; but for the present I have sufficiently trespassed upon your space.

F. GOWLAND HOPKINS,
Guy's Hospital, S.E., April 9. Gull Research Student.

"C.G.S. System of Units."

THE new edition of Prof. Everett's "C.G.S. System of Units" contains, at the very beginning, two misleading statements, based seemingly on a misapprehension of facts. In so valuable a work, such errors are to be deplored.

Pp. xiii. and xiv. give an account of weighings made at the International Bureau of Weights and Measures between certain "standard pounds" and the international standard of mass.

From the statement as given, it would be inferred that there is room for doubt as to the relation between the British standard of mass and the international kilogramme.

The real facts are, that the standard pounds were only nominally "pounds"; they were standards with known corrections, which, however, have not been applied to the equivalents given on p. xiv.

The true relation of the Imperial pound to the international kilogramme is given in the Board of Trade Report of Proceedings under the Weights and Measures Act, 1884 (p. 4), according to which the Imperial pound = 453·5924277 grammes.

On p. 34 of "C.G.S. System of Units," Mr. Chaney's results of the weight of a cubic inch of water are discussed, and the conclusion is reached that Mr. Chaney's result differs by 0·00125 from the theoretical relation between volume and mass of water in the metric system.

This result is obtained by comparing Mr. Chaney's results, without reduction to *vacuo*, with the mass of a cubic centimetre of water.

Mr. Chaney states that the standard air to which his result is reduced weighs 0·3077 grains per cubic inch. Therefore his result reduced to *vacuo* is: one cubic inch of water at 62° F. weighs 252·286 + 0·308 = 252·594 grains.

If we take the value for the thermal expansion of water, in terms of the hydrogen thermometer scale, as determined at the International Bureau, we find the density of water at 16°·667 C., = 62° F., referred to its maximum density = 0·998861.

Using the equivalents 1 metre = 39·3700 inches, and 1 gramme = 15·43235639 grains, we obtain: one cubic inch of water at 62° F. weighs *in vacuo* 252·6045 grains; while Mr. Chaney found 252·594 as above given, a discrepancy of one part in 25,000 only, as compared with one part in 800, given by Prof. Everett. It is not clear from Mr. Chaney's statement whether his weight in air is against brass or other weights; therefore the vacuum reduction above applied is uncertain by a small amount. O. H. TITTMANN.

Washington, D.C., March 10.

MR. TITTMANN thinks the true relation is, without doubt—

1 pound = 453·5924277 grammes.

Prof. W. H. Miller determined it to be—

1 pound = 453·59265 grammes,

which is the value given on the Card of Equivalents published by the Board of Trade. If the determination quoted by Mr. Tittmann from a Board of Trade Report of 1884 was made under such conditions as to render it authoritative, it is a pity it has been allowed to remain for eight years buried in a Blue-book. One would have expected some intimation of it to be given to scientific men through the Royal Society or in the pages of NATURE.

As regards the three "standard pounds" which were compared with standards at the Bureau International in 1883, Mr. Tittmann says they had known corrections. This is not stated in the *Travaux et Mémoires*, where the account of the comparison is given. There is, however, in the case of the two which are of gilded bronze, a reference to a description of them by Prof. Miller in his paper on the standard pound (Phil. Trans. 1856), and, on turning to it, I find that their errors, as stated by him, do not agree even approximately with the determinations made at the Bureau. They differ even in the first significant figure of the error, which is the sixth figure of the entire value; so that, as far as this evidence goes, the five figures 45359 are all that are certain.

As regards the other matter referred to, Mr. Tittmann does not mention the publication in which "Mr. Chaney states that the standard air to which his result is reduced weighs 0·3077 grains per cubic inch." The only publication known to me is Mr. Chaney's paper in the Proceedings of the Royal Society, and it does not contain any such statement.

I have always been taught to regard a standard weight as a standard of mass, and therefore independent of such conditions as temperature, pressure, and the material in the other scale pan; whereas, it appears that Mr. Chaney, by direction of the Board of Trade, has made a determination which is only true for a particular density of the surrounding air, and a particular density of the weights in the other pan.

For scientific purposes a standard of reference should be free from variable elements, and should be of the utmost attainable simplicity. For commercial purposes determinations to six figures are frivolous.

Mr. Tittmann's reductions appear to contain two errors. Instead of adding the weight of a cubic inch of air, he ought to have added the difference between this and the weight of the air displaced by the weights in the opposite pan. Again, he takes the metre as 39·3700 inches, whereas Clarke's value is 39·370432, and Kater's 39·37079.

I have had some correspondence with Mr. Chaney since the publication of my new edition, and have had an erratum slip printed, which I trust you will allow me to subjoin, as it may be useful to several of your readers J. D. EVERETT.

5 Princess Gardens, Belfast, March 28.

Addenda and Corrigenda.

Page 63. In reducing Cailletet's experiments, ·000 0026 should have been added instead of ·000 0039.

Page 77. *Add*—Violle's determination of velocity of sound is 331·10 ± 0·1. *Ann. de Chim. XIX. March*, 1890.

Page 176, line 10. *For* Wuilleumeier, 1890, *read* Wuilleumier, 1890, Lippmann method.

At end of page 164, *add*—Expressing C in amperes, R in ohms, and T in seconds, the heating effect in gramme-degrees is $C^2RT/4{\cdot}2 = {\cdot}24C^2RT$.

Page 35. Mr. Chaney's determination here quoted was not intended as a determination of the *density* of water, but of the *apparent weight* of water when weighed in air of density ·001 216 84 against brass weights of density 8·143. The correcting factor for deducing the weight *in vacuo* or true density is 1·001 0687, which will change the value ·998 752 obtained in the text into ·999 82, to compare with Tralles' ·999 88.

Mr. Chaney's result is for distilled water deprived of air, and Tralles' appears to be for ordinary distilled water. According to results recently obtained by the Vienna Standards Commission (*Wied. Ann.*, 1891, Part 9, p. 171), water deprived of air has the greater density, the difference being ·000 0032 at 0° C., and ·000 0017 at 62° F. These differences are too small to affect the above comparison.

Influenza in America.

IN my copy of "Johnson's Dictionary of the English Language in Miniature, to which are added an alphabetical account of the heathen deities and a copious chronological table of remarkable events, discoveries, and inventions, by the Rev. Joseph Hamilton, M.A., second American edition, Boston, 1806" (12mo, pp. 276), I find on p. 275, "Influenza in North America, 1647, 1655, 1697–98, 1732, 1737, 1747, 1756–57, 1761, 1772, 1781, 1789–90, 1802."

It is quite possible that these dates are well known, but they are new to me, and may be of interest in connection with the recent epidemic. EDWARD S. HOLDEN.

Mount Hamilton, March 29.

DUST COUNTING ON BEN NEVIS.

WITHIN the last few years quite a new factor has been introduced into the study of meteorology—namely, that which treats of the dust particles in the atmosphere, of the number of dust particles present in the air at any time, and the effect of dust in the air on climate and weather changes. It is now beginning to be recognized that the study of dust and its behaviour in the air forms the stepping-stone to the study of almost all meteorological problems which deal with clouds and precipitation, solar and terrestrial radiation, and in a general way with the diurnal and annual variations in the temperature and pressure of the atmosphere. Mr. Aitken's work in originating this branch of science, and in making and discussing numerous observations of the number of dust particles in the air of various places in this country, as well as on the Continent, at various altitudes, is pretty well known already (see NATURE, vol. xli. p. 394). Mr. Aitken's results and conclusions were looked upon as being of such importance as to warrant some of our leading meteorologists to apply to the Research Fund of the Royal Society for a grant to enable them to equip the Ben Nevis Observatory with Aitken's dust-counting apparatus. The application was successful, and instruments were at once ordered, and in due time erected at the Observatory.

The apparatus consists of two dust counters, one a portable form for use in the open air, and the other a laboratory form for use inside the Observatory. The latter is fixed in the middle room of the tower, and has pipes leading out to the free air, so that it is possible to observe with it in almost all sorts of weather and at any hour day or night. The principle on which these instruments are constructed, so as to make the tiny invisible particles of dust visible and easily countable, is pretty well known already. Briefly it is this. To make the particles visible, the air containing them is saturated with water vapour, and by a stroke of an air-pump it is thereafter cooled so much as to cause a condensation of the vapour on the particles, whereby these are thus made visible. Ordinary air is so dusty that if the receiver were full of such air it would be impossible to count the particles, and to make them easily countable the following process is resorted to. First, the chamber or receiver, whose capacity is accurately known, is filled with pure dustless air by means of an air-pump and filter. Then a fifth, a tenth, or any other fractional part of the amount of pure air inside is taken out, and the same amount of dusty air allowed in. In this way the density of the shower caused by condensation is completely under the observer's control. A small graduated stage is placed one centimetre from the top of the receiver, so that all the dust above this falls on to it, and by means of a magnifying glass all the particles on one or more of the small squares of the stage are easily counted. Then, by multiplying by the reciprocals of the various fractions used we arrive at the number of dust particles in a unit of the free dusty air. In making an observation, the mean of ten such tests is taken as the number of particles present for that time.

Observations were begun at the Ben Nevis Observatory with the portable instrument in February 1890, and with the other instrument in the following summer. During the whole of that year the work done was mainly preliminary, as great difficulty was experienced in getting the dust work to fit into the general routine of Observatory work. The dust inquiry is not like some other special inquiries, that can be prosecuted for a certain time, and then discontinued after definite positive or negative conclusions thereanent have been arrived at, but must, on the other hand, be carried on side by side with the other observations of meteorological phenomena, as pressure, temperature, humidity, &c., with any of which it is of equal importance, and having once been admitted into the general routine of meteorological observations it must be kept on. This fact was soon seen on Ben Nevis from the extraordinary variations that were observed in the dustiness of the air with changes of weather; and it was attempted to make continuous hourly observations of the dust as of the other elements. It was found, however, that this could not be done without crippling the general routine, this being as much as the two observers at the Observatory could well cope with. In February 1891 a system of three-hourly observations of the dust particles was started, and this has been kept up with but few interruptions since. The dust observation is made immediately after the usual hourly set is completed, and it can thus be studied along with all the other hourly records in their relation to the prevailing weather.

A great many observations have in this way been accumulated during the past two years, but we have not had time for studying them in detail yet. A mere inspection, however, brings out some interesting points. One of these is the enormous variation that is observed in the number of dust particles, not only in the course of the year, but often in the course of a few hours. At sea-level the number of dust particles in the air at any time depends very much on the locality and on the wind, whether blowing from a polluted district or not. The mean of a number of observations made by Mr. Aitken at Kingairloch, in the west of Scotland, is 1600 particles per cubic centimetre. In London, on the other hand, he found 100,000 per cubic centimetre, and in Paris rather more. On Ben Nevis the mean is 696 per cubic centimetre, the maximum being 14,400 per cubic centimetre, and on several occasions the minimum fell to 0. A general mean does not convey a fair idea of the dustiness of the air at the mountain-top, although it may do so for places at sea-level, because there is at the former place a great daily range in the number of dust particles, depending on the rise and fall of the air past the place of observation. If there is any marked variation at sea-level it is entirely of a different character. Below are the means, as well as the maxima and mimima, of all the months that have a fairly representative number of observations.

Number of Dust Particles per cubic centimetre on Ben Nevis.

1890-91.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Nov.
Means . .	(1,515)[1]	1,037	2,300	1,757	(700)	(588)	(606)	418
Maxima . .	6,350	12,862	14,400	4,940	3,850	4,000	1,286	3,150
Minima . .	4	0	11	4	50	0	67	12

The above table shows that the Ben Nevis air contains most dust in spring, and it is probable that sea-level air is in this respect similar; the cause of this greater amount of dust in spring than at any other time of the year being the great annual westward motion of the whole atmosphere, or at least of a considerable depth of it, at that time of the year. In a recent paper on "The Winds of Ben Nevis" (Trans. R.S.E., vol. xxxvi. p. 537), it has been shown that this is one of the very few points in which the high- and low-level winds agree, viz. in the excess of easterly winds in spring. The above means for summer are probably too low, as that summer was exceptionally cold, and the general circulation was very abnormal, and that in the direction which would tend to give low dust values. The maximum, 14,400, was observed at 1 p.m. on April 11, 1891; and, as an instance of how very much the values change in a short time, at 8 a.m. that morning the number was only 350 per cubic centimetre, and by midnight it had again fallen to 600 per cubic centimetre.

The daily variation is fairly well indicated from the three-hourly observations. For the months of March, April, and May, 1891, the following are the means for the eight hours of observation:—

Number per cubic centimetre.

Hour.	1	4	7	10	13	16	19	22	Day.
Means . . .	736	526	570	551	950	1438	1035	1029	854
Difference from mean—									
Above . .	...	...	...	...	96	584	181	175	...
Below . .	118	328	284	303	...	...	...	...	...

[1] Bracketed values are for 1890 only.

Here there is a minimum indicated (526) at 4 a.m., and a maximum (1438) at 4 p.m. All the forenoon values are below the mean, and the evening values above it. It would appear that during the forenoon the summit of Ben Nevis is above the first or lowest cloud or dust stratum. About noon this stratum rises to the level of the summit, and during the afternoon hovers above it, and falls again late at night. From this it might be inferred that the summit is oftener clear of cloud in the early morning, and oftener enveloped in the afternoon. A table showing the number of times the top was clear during the last seven years shows that only about 30 per cent. is clear weather in which the summit is free from fog; but it does not show a daily variation as indicated by the dust values, what little it does show being quite the reverse—namely, a maximum of clear weather in the middle of the day and a minimum at night. This clearly indicates that when the dust layer falls below the summit at night, radiation at once forms an independent cap on the hill-top; and again in the afternoon, although the dust stratum envelopes the summit, the opposite radiation warms it up and prevents condensation, or rather evaporates the watery particles of the cloud. So that, contrary to public opinion, the best time to visit the summit for the sake of the "view" is the middle of the day, and not the early morning. During fine settled weather the rise and fall of this cloud stratum can be followed, but in average weather the effect of radiation completely masks it. The effect of solar radiation and nocturnal radiation on dust, as particles and as strata, is a problem that has to be studied and worked out. Very little is definitely known about it at present.

In the study of the nature and motions of clouds the dust observations will be of great value. When a fog envelopes the summit, the number of dust particles observed may vary greatly without any apparent change in the thickness of the fog, but as a rule dry thick fog contains a great amount of dust, while thin wet mist contains very little. It is when a thin drizzling mist envelopes the summit that the lowest values are always obtained, and then there is a distinct difference between the conditions at sea-level and those at the summit, the winds at the latter place differing in direction by 90° or more from the winds below, and sometimes the upper winds are blowing straight out from the centre of a shallow low-pressure area, and the dust that rises with the slight ascending currents of the lower strata is almost entirely filtered out before reaching a height of 4400 feet. One of Mr. Aitken's conclusions may briefly be put as follows: Much wind, little dust; much dust, little wind. That dust seems to accumulate in the quietest places is fully borne out by the Ben Nevis observations. This is true not only horizontally, but also vertically, and it seems probable that this is what chiefly determines the position of cloud strata at all heights. And from this we may infer that the motion of clouds is much slower than that of the general aërial currents; and again, since clouds tend to form between currents, and may have as direction of motion the resultant of the directions of these currents, it follows that as indices to the motions of the upper air the velocity and motion of clouds are very unsatisfactory.

Observations of the apparent haziness of the atmosphere are made whenever it is possible, and the relations between the haziness of the air, the humidity, and the number of dust particles, have been found to be the same as what Mr. Aitken pointed out. Briefly, he found that with a constant humidity the haziness increased or diminished with the number of dust particles, and with a constant number of dust particles the haziness depended on the humidity (at least when the air was within 10 or 15 per cent. of saturation); for with increase of humidity the air became thicker, because apparently condensation begins on the dust particles before the air reaches its point of saturation.

The dust observations promise to be of special value in the study of weather types. In some weather types, not only are the dust values very abnormal, but the daily variation is in some instances quite abnormal also, indicating that the cloud or dust strata are differently situated from what they are in average weather, and also that their daily rise and fall occur at different times. In March 1890, the dust values show this very well: below are the three-hourly means for each of three different periods:—

Hour	1	4	7	10	13	16	19	22
	First Period (12 *days*).							
Number per cubic centimetre . .	78	61	78	67	113	408	258	102
	Second Period (3 *days*).							
,,	2867	1785	917	4733	4213	4295	3417	2533
	Third Period (5 *days*).							
,,	65	25	37	19	20	28	93	76

During the third period of five days the weather was very remarkable. A large depression was slowly progressing eastwards to the north of Scotland, and the winds on Ben Nevis were blowing almost straight out from the centre, while the winds at sea-level were circulating in the normal direction. This is the usual type when low dust values are obtained; but it is difficult to quite account for the daily variation in the dust values being reversed, the higher values occurring at night, and the lower in the middle of the day. This and many other points have not been studied yet.

Dr. Buchan, in his recently published work on "Atmospheric Circulation," hinges his explanations of various atmospheric phenomena on the effect of solar and nocturnal radiation on the dust in the atmosphere, and accounts it one of the most important factors in the study of modern meteorology. The observations made at Ben Nevis Observatory clearly show that for observing the number of dust particles in the air, with a view to the observations being applied to the study of atmospheric phenomena, a true peak is of all places the best, because we can study not only the horizontal distribution of dust as brought by the different winds, but also, to a certain extent, the vertical distribution by the ascending and descending motions of the air past the place of observation.

ANGUS RANKIN.

ABSTRACT OF MR. A. RICCO'S ACCOUNT OF THE SUBMARINE ERUPTION NORTH-WEST OF PANTELLERIA, OCTOBER 1891.[1]

OF what happens in submarine eruptions we naturally know little. The evidence of Graham's Island (1831)[2] and the eruption off Pantelleria (1891), to the south of Sicily, and of the damaged telegraph cables and various surface phenomena[3] to the north, towards the Lipari Isles, shows us that such eruptions are not rare in the Sicilian district, and any records of these fleeting occurrences that we can get, in the way of observation and specimens, may well prove of increasing interest as others are obtained to compare with them.

Mr. A. Ricco has recently published[1] a detailed and illustrated account of the facts he was able to gather, concerning last October's submarine eruption north-west of Pantelleria, either in person or from local and other observers, he having reached the island during the latter part of the eruption. From this, at the suggestion of Prof. Judd, who has kindly sent me a copy, I extract the following:—

Pantelleria, an island (13·5 by 8 kilometres), situated between Sicily and Tunis, is entirely of volcanic origin.[1] The volcanic activity would at present appear to be a shade less marked than in the "Phlegræan Fields," west of Naples.

In Pantelleria we have exhalations of CO_2; hot springs (of which those at the lake called "Bagno del Acqua," among other things are, we are told, so rich in alkalies as to lather, and be used for washing clothes!), and fumaroles, some of which exhale steam harmless to vegetation, and with little if any specific effect on the rocks, while others give out sulphurous vapours at 88° C. or more, decomposing the rocks about them.

There is but doubtful record of seismic disturbances in the island prior to the summer of 1890. Then, however, earthquakes occurred, with elevation of part of the north coast, the cracking of cisterns, and an increase in the number and activity of the fumaroles, so that vineyards formed in some of the old craters were damaged. After more than a year's interval, earthquakes again commenced October 14, 1891 (three days before the eruption). These were accompanied by drying up of certain springs, and apparently a further rise on the north coast, with surface cracks in that district.

As the shocks were most violent and vertical at the little town of Pantelleria itself (at the end of the island nearest the scene of eruption), they caused considerable consternation; and if one went by the account of the overstrung inhabitants, who felt shocks not recognized by the seismoscopes, one might exaggerate their violence. On the other hand, the walls of the houses, which outside the town have frequently no upper story, are, on the whole, substantially built, so that the insignificant damage done is perhaps hardly a gauge. Part of the north coast (Fig. 1) appears to have been raised, in the two years,

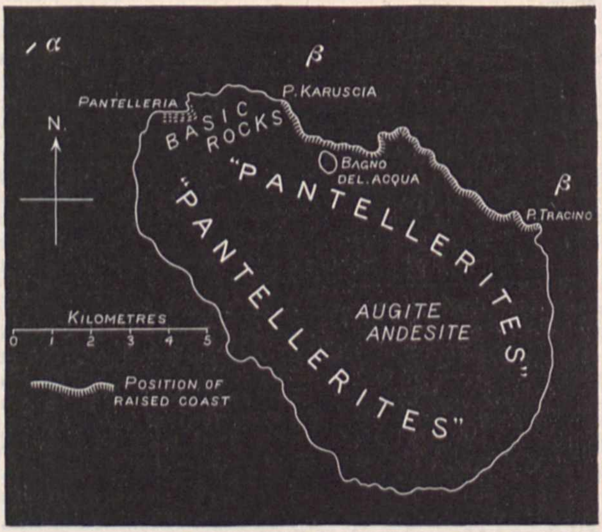

FIG. 1.—Map of Pantelleria, showing the position, according to Ricco, of (α) the submarine eruption of October 1891, and (β, β) of the raised coast.

some 80 cm., the old sea-level being marked by a line of white incrustations; and we are told that, according to a recent estimate,[2] the tide in this part of the Mediterranean has an amplitude of but some 8 cm.; besides, there was the evidence of inhabitants who had bathed, boated, and fished along the coast. The submarine eruption (4 kilometres north-west of the island, Fig. 1) began on

[1] *Annali dell' Ufficio centrale Meteorologico e Geodinamico*, ser. ii., Parte 3, vol. xi.

[2] (*a*) Lyell's "Principles of Geology"; and (*b*), for Bibliography, Johnston-Lavis's "South Italian Volcanoes," pp. 105–107.

[3] (*a*) "South Italian Volcanoes," pp. 64 and 65; and (*b*) Giov. Platania, "I Fenomeni Sottomarini durante l'Eruzione di Vulcano (Eolie) nel 1888–1889," *Att. Rend. Acc. Sc. Let. Art. Acireale*, n. ser., vol. i., 1889, pp. 16, tables 3.

[1] Foerstner, "Nota preliminare sulla Geologia dell' Isola di Pantelleria" (with geological map), *Boll. Com. Geol. d'Ital.*, 1881.

[2] Prof. G. Grablovitz, "Le isorachie della marea nel Mediterraneo," *Rendiconti della R. Accad. dei Lincei*, 16 Agosto, 1891.

October 17, 1891, when the earthquakes abated, and water returned to some of the wells. The appearance of the sea, as viewed from the land, at first suggested the presence of some "great fish," and columns of "smoke" were seen. Those who visited the spot later (Fig. 2) found black

FIG. 2.—Part of a sketch of the submarine eruption near Pantelleria, October 1891. (After Ricco.)

scoriaceous bombs rising to the surface, along a line some 1 kilometre in length, extending north-east and south-west, which might well indicate a submarine fissure, the activity being specially great at certain points. Some of the bombs discharging steam ran hissing over the water with the recoil. Many were still very hot inside, fusing zinc (415° C.), and one was red-hot (in daylight), but below 800° C. Some pieces were thrown 20 m. in the air, as I gather, not so much by their momentum on reaching the surface as by the explosions occurring there. After the explosions the fragments sank, the material having a sp. gr. of about 2·4. The highest temperature of the water obtained was but 1½° C. above that of the surrounding sea. Ricco now questions the trustworthiness of the soundings made at the scene of eruption to a depth of 350 m. without feeling bottom, and he was told that fishermen had previously found but 160 m. of water there. Though some saw bubbles rise to the surface, the gases usually emitted in the case of subaërial eruptions were not detected in the sample of water collected, which Riccò suggests may be due to their having been taken into solution by the water lower down. However, there was a smell "as of gunpowder" at the spot; and the dark, basic, spongy matter of the bombs (previously described),[1] "the only solid material erupted," gives out when heated a sulphurous odour, a fact of which Mr. F. Chapman had previously informed me. The eruption terminated on October 25, and the erupted matter disappeared.

I should add, in conclusion, that I have ascertained from Dr. Errera, who has charge of the seismological apparatus on the island, that the telegrams published in an English daily paper, as to renewed eruptions in the neighbourhood at a later date, were quite without foundation.

G. W. BUTLER.

March 22.

GIRAFFES.

THE Zoological Society of London, as our readers know, have lost their last remaining Giraffe, and, for the first time since 1836, no example of this, one of the most wonderful of living Mammals, is to be seen in the Regent's Park Gardens. Nor does it seem likely that the loss can be easily restored. At the present time, owing to the Mahdists having closed the Soudan to trade, the Giraffe-market is very poorly supplied. Only one specimen of this animal, we are told, is for sale in

[1] NATURE, vol. xlv. p. 251.

Europe, and an exorbitant price is naturally asked for it. In South Africa the Giraffe is practically extinct, being only still met with in a few isolated localities nearly a thousand miles from Cape Town. In East Africa there are still Giraffes, and in places nearer the sea-board; but here, apparently, there are no means of catching them alive, as the natives do not understand how to do it. Here, however, it is that there appears to be most likelihood of obtaining a fresh supply. This will be an expensive business, but unless some steps are soon taken in the matter it seems that the younger generation of England will grow up without knowing what a living Giraffe is like. Their parents have been more fortunate. From the list given below, it will be seen that there have been 30 individuals of the Giraffe exhibited in the Zoological Society's Gardens since 1836, of which 17 have been born there, and 13 acquired by purchase. Of these 30, one was presented to the Royal Zoological Society of Ireland in 1844, five have been sold at prices varying from £450 to £150, and the remainder have died in the Gardens.

List of Giraffes that have lived in the Society's Gardens.

No.	Sex.	How obtained.	How disposed of.
1	♀	Imported May 24, 1836.	Died Oct. 15, 1852.
2	♂	Do. do.	,, ,, 29, 1846.
3	♂	Do. do.	,, Jan. 14, 1849.
4	♂	Do. do.	,, Jan. 6, 1837.
5	♂	Born in the Menagerie, June 19, 1839.	,, June 28, 1839.
6	♂	Do. do. May 24, 1841.	Presented to the Dublin Zoological Society, June 14, 1844.
7	♂	Do. do. Feb. 25, 1844.	Died Dec. 30, 1853.
8	♂	Do. do. April 22, 1846.	,, Jan. 22, 1867.
9	♂	Do. do. Feb. 12, 1849.	Sold April 27, 1850.
10	♀	Imported June 29, 1849.	Died Nov. 3, 1856.
11	♀	Do. do.	Sold Oct. 29, 1853.
12	♂	Born in the Menagerie, March 30, 1852.	,, March 29, 1853.
13	♀	Do. do. April 25, 1853.	Died May 21, 1872.
14	♀	Do. do. May 7, 1855.	,, Nov. 6, 1866.
15	♀	Do. do. July 16, 1859.	,, Dec. 2, 1859.
16	♀	Do. do. May 26, 1861.	Sold May 1, 1863.
17	♂	Do. do. Oct. 7, 1861.	Died Dec. 18, 1861.
18	♂	Do. do. May 8, 1863.	,, Nov. 18, 1863.
19	♂	Do. do. Sept. 24, 1863.	,, April 21, 1864.
20	♂	Do. do. Mar. 31, 1865.	,, April 3, 1865.
21	♀	Do. do. April 20, 1865.	Sold May 31, 1866.
22	♂	Do. do. Sept. 14, 1866.	Died Nov. 6, 1866.
23	♂	Do. do. Mar. 17, 1867.	,, June 20, 1881.
24	♀	Purchased July 23, 1867.	,, Sept. 12, 1869.
25	♂	Do. Jan. 5, 1871.	,, April 27, 1874.
26	♀	Do. Oct. 11, 1871.	,, May 21, 1878.
27	♂	Do. July 25, 1874.	,, Jan. 8, 1879.
28	♀	Do. do.	,, July 9, 1886.
29	♀	Do. do.	,, Nov. 24, 1891.
30	♂	Do. Jan. 27, 1879.	,, March 22, 1892.

NOTES.

THE ordinary general meeting of the Institution of Mechanical Engineers will be held on Thursday evening, May 5, and Friday evening, May 6, at 25 Great George Street, Westminster The chair will be taken at half-past seven p.m. on each evening, by the President, Dr. William Anderson, F.R.S. The President will deliver his inaugural address on Thursday evening, after which the following papers will be read and discussed, as far as time permits:—Research Committee on Marine-Engine Trials: Report upon trial of the steamer *Ville de Douvres*, by Prof. Alexander B. W. Kennedy, F.R.S., Chairman (Thursday, and discussion continued on Friday). On condensation in steamengine cylinders during admission, by Lieut.-Colonel Thomas English, of Jarrow (Friday). The anniversary dinner will take place on Wednesday evening, May 4.

THE Royal Academy of Sciences of Lisbon has elected Sir Joseph Fayrer, F.R.S., as a foreign corresponding member in the class of mathematical, physical, and natural sciences.

DR. R. THORNE THORNE, F.R.S., as was expected, has been appointed principal Medical Officer of the Local Government Board, in succession to Sir George Buchanan, F.R.S.

WE regret to have to record the death of Miss Amelia B. Edwards. She died on Friday last at Weston-super-Mare. Miss Edwards had done much both in England and in America to awaken public interest in the results of archæological research in Egypt. She also did excellent service by her work in connection with the organization and control of the Egypt Exploration Fund.

MR. J. CARRUTHERS, son of Mr. W. Carruthers, head of the Botanical Department of the British Museum, has been appointed Lecturer in Botany at the College of Agriculture, Downton, for the coming summer. Mr. J. Carruthers has for some time been Demonstrator in Botany at the Royal Veterinary College, London.

AN International Economic Congress will be held at Antwerp in August next.

MR. W. CLAYTON PICKERSGILL, H.B.M. Vice-Consul at Antananarivo, who has just returned to England on leave, has brought with him a nearly perfect egg of the extinct gigantic Bird of Madagascar, *Æpyornis maximus*. This was obtained, like all other previous specimens, from the southern coast of the island, near Cape Ste. Marie. Mr. Sclater will exhibit the egg at the next meeting of the Zoological Society, on May 3.

ALL collections of plants received at the Royal Gardens, Kew, are examined, and reports upon them are sent to the donors. When of sufficient magnitude and importance, they are made, as in the case of the late Colonel Grant's collections in Central Africa, the subject of a detailed memoir. Anything of sufficient interest in smaller collections is illustrated with a plate in "Hooker's Icones Plantarum." Novelties which are not important enough to justify a plate have hitherto been relegated to their proper places in the Herbarium, where they have awaited description by some monographer. Collectors, however, are best encouraged when they see that the result of their labours supplies some tangible addition to scientific knowledge; so it has been decided that all plants received at Kew of which the novelty can be ascertained with some certainty shall be described for the information of botanists, and distinguished by formal names. Successive decades of plant-descriptions are to be published in the *Kew Bulletin*. The first decade appears in the April number, and suffices to indicate that the series will be one of great interest and value.

BESIDES the first of the "Decades Kewenses," the April number of the *Kew Bulletin* contains sections on Fiji ginger, the agricultural resources of Zanzibar, and the botanical station, St. Vincent.

WE learn from the *Kew Bulletin* that among the botanical treasures which have lately reached the Royal Gardens, is a second small collection of dried plants, sent by the Rev. R. B. Comins from the Solomon Islands. It includes several highly interesting things. Specially interesting among these are flowering specimens, though not perfect, of the tree that bears the so-called turtle-seeds of the islanders. This tree belongs to the *Sapotaceæ*, and will shortly be published as a new genus of that order by Mr. W. B. Hemsley. The seeds are one of the most singular productions in the vegetable kingdom, and the name given to them by the natives of the Solomon Islands is quite appropriate, as the resemblance is most striking. Mr. Comins collected seeds of what appears to be a second species of the genus, and Kew previously possessed a seed and foliage of a third species, collected in the Fiji Islands in 1878 by Mr. Horne, the Director of the Botanic Garden of Mauritius. There are also seeds of one or two other species in the Museum, where they have been for some years, but their origin is unknown. The *Bulletin* also calls attention to another very curious plant collected by Mr. Comins—*Lasianthera papuana*—in which the originally three-celled ovary develops into a fruit with one fertile, dry, woody cell, the two empty cells forming a fleshy body on one side of it.

IT is expected that the Borough Road Polytechnic Institute will be opened in October next. When the ceremony has taken place, two of the three Polytechnics for South London, for which Mr. Evan Spicer and his committee first appealed in 1888, will be at work. The Goldsmiths' Company's Institute at New Cross, which by the munificence of that Company was opened in October last, has considerably over 4000 members on its books. The third Polytechnic, that at Battersea, is in a fair way towards completion, and will, it is hoped, be opened in October 1893.

PROF. T. G. BONNEY, F.R.S., will on Tuesday next, April 26, begin a course of two lectures at the Royal Institution, on "The Sculpturing of Britain: its later stages"; and on Thursday, April 28, Prof. Dewar, F.R.S., will begin a course of four lectures on "The Chemistry of Gases." The Friday evening meetings will be resumed on April 29, when Dr. Benjamin W. Richardson will deliver a discourse on "The Physiology of Dreams."

MR. ALFRED W. BENNETT will deliver a course of lectures on systematic botany at the Medical School, St. Thomas's Hospital, on Tuesday and Wednesday mornings at 10 a.m., beginning Tuesday, May 3.

DR. SYMES THOMPSON will deliver at Gresham College, on April 26, 27, 28, and 29, a course of lectures on "The Eye in Health and Disease." The lectures are to be illustrated by diagrams, and will begin each evening at six o'clock.

ACCORDING to a Reuter's telegram, despatched from New York on Monday, two severe shocks of earthquake were felt at Portland, Oregon, at two o'clock on Sunday afternoon, and at various places in the vicinity. Numbers of buildings trembled, and so great was the alarm that people rushed panic-striken into the streets. The vibrations were from west to east, lasting ten seconds in each case. No damage was done, and as the seismic disturbances were confined to two sharp shocks within a brief interval of each other, a feeling of confidence gradually returned.

SNOWSTORMS of exceptional severity have passed over the country during the last week, and in many parts of the kingdom the fall was heavier than at any time during the past winter. In Scotland, and over the northern parts of England, snow had been falling heavily on several days, and on Good Friday a shallow cyclonic storm area was approaching our south-west coasts from off the Atlantic, which occasioned heavy snowstorms in the Channel Islands and south-west of England. The central area of this disturbance passed up the English Channel and over the north of France, accompanied by an unusually heavy fall of snow over the south and south-east of England. The ground was covered in places to the depth of several inches, and the storm caused considerable damage to the telegraph wires in the southern parts of the kingdom. The night frosts were also very severe, the shade thermometer registering as low as 20° in places.

THE Report of the Kew Committee of the Royal Society for fourteen months ending December 31 last gives an account of the observational and experimental work of the Observatory. The curves of the magnetographs have shown a marked increased activity in terrestrial magnetic changes as compared with the previous year, although no very large disturbances have been registered. The electrograph has been maintained in action during the greater portion of the year, but the instrument has failed in sensibility, owing to the diminished potential of the chloride of silver battery. The subject of the measurement of atmospherical electricity is consequently far from settlement. Sketches of sun-spots were made on 170 days, and the groups numbered after Schwabe's method. Two new forms of anemometer have been under trial: (1) the anemo-cinemograph of MM. Richard Frères, similar to that employed at the top of the Eiffel Tower—the vanes, by running constantly against a train of clock-work, record directly on a sheet of paper the velocity of the wind at any moment; (2) the Munro sight-indicating anemometer is a sensitive Robinson cup arrangement, which drives, by means of a small centrifugal pump, a column of oil up a glass tube. The instrument, as fitted at present, fails to work during frost, owing to congelation of the oil employed. Great activity continues to be shown in the verification department, over 20,500 instruments of all kinds having been tested; more than three-fourths of these were clinical thermometers. In the rating of watches, the highest position was attained by Messrs. Stauffer, Son, and Co., one of whose watches obtained a total of 91·6 marks out of a possible 100. Special circulars have been addressed to the directors of steamship companies, calling attention to arrangements made for the rating of chronometers. A special camera, capable of working with lenses of 4 inches aperture and 30 inches focal length, has been fitted up at the Observatory, for the examination of photographic lenses. A photometer, on Captain Abney's principle, 13 feet long, has also been fitted for use in the testing operations. The Committee have come to the conclusion that it would be of advantage to them to obtain registration under Section 23 of the Companies Act, 1867.

WE have received from the Deutsche Seewarte, (1) the *Deutsches meteorologisches Jahrbuch* for 1890, containing observations taken three times daily at nine stations of the second order, with monthly and yearly results, hourly observations and means at Hamburg and Wustrow, and extracts from the registers kept at the signal stations, on stormy days. The materials are similar to those published in former years, the only change being in the reduction of the number of stations for which observations from self-registering instruments are given. (2) *Ergebnisse der meteorologischen Beobachtungen* for the lustrum 1886–90, on the same plan as those previously published for the years 1876–80 and 1881–85. These publications extend over fifteen years, and form a very valuable contribution to the climatology of Northern Germany, affording ample data for investigations referring to individual hours, or days, together with an easy means of obtaining the combined results and the extreme values for the whole period over which the observations extend.

THE Washington Weather Bureau has just issued an atlas of thirty-six charts, being one of a series of useful works partially prepared under the superintendence of General A. W. Greely, Chief Signal Officer of the United States, prior to the transfer of the Meteorological Service. The charts show the average direction and hourly velocity of the wind at 8 a.m. and 8 p.m. (Washington time), at sixty-five representative stations, with the average maximum and minimum hourly velocity, and other interesting details, from observations for a number of years. The prevailing wind direction, and the direction next in order of frequency, are shown by arrows which fly with the wind, while figures set against the arrows indicate the percentage of times the wind has been observed in the direction indicated by the arrows. General Greely remarks that the diurnal variation of the wind in the United States has not been investigated to any considerable extent, so that but little is known of its tendency except in a general way. It may be said, however, that in the northern hemisphere there is a well-defined tendency to veer a little in the morning, and to back through the same circumference in the afternoon. This inclination, however, is early subordinated to the influence of pressure changes and distribution, and cannot be detected except in settled weather.

WRITING in the American journal *Electricity*, on electricity in the United States Navy, Mr. W. B. Lefroy Hamilton refers to the working of the search light. He says that in the practical use of the search light, it has been found that in order to afford sufficient time for a careful examination of the water's surface, at points far removed from the ship, the beam of light must be revolved very slowly, and in consequence, during a great portion of the time any particular section of water is left in darkness. As it only takes five minutes for a torpedo boat to run a distance of two miles, it will be easily seen that in the interval between two successive illuminations of the same spot, a torpedo might attack a warship and discharge her deadly weapon. To overcome this difficulty, it is proposed that the new American war-ships, beginning with the *New York*, shall be fitted with a number of stationary search lights grouped together, each illuminating its own section, thus keeping the ship surrounded by an unbroken circle of light.

THE leather industry is to have a separate building at the Chicago Exhibition. Representatives of the industry have accepted a site offered them, and will erect, at an expense of 100,000 dollars, a building, measuring 150 by 600 feet, in which they will show an almost endless array of leather products, and every process in their manufacture from the raw hide to the most finished article.

THE latest annual report of the Hon. Edgar Dewdney, Superintendent of Indian Affairs in Canada, gives much interesting information as to the aborigines of the Dominion. They are distributed thus:—Ontario, 17,915; Quebec, 13,361; Nova Scotia, 2076; New Brunswick, 1521; Prince Edward Island, 314; Manitoba and North-West Territories, 25,195; Peace River district, 2038; Athabasca district, 8000; Mackenzie River district, 7000; Eastern Rupert's Land, 4016; Canadian Labrador, 1000; Arctic coast, 4000; British Columbia, 35,202—total, 121,638. The number of children of school age is 13,420, of whom 7574 are in attendance. Even in the North-West, where the conditions are harder than in British Columbia, great progress has been made. The property owned by the Manitoban and North-Western Indians includes 5599 houses and 2018 barns; 13,549 acres of land under cultivation, with 2115 acres newly broken; 1251 ploughs, 773 harrows, 899 waggons, 48 fanning mills, and 5 threshing mills; 2928 cows, 70 bulls, 2064 oxen, 4823 calves, 5879 horses, 428 sheep, and 215 pigs. Last year the North-Western Indians reaped a harvest including 67,726 bushels of wheat, 21,592 of oats, 19,761 of barley, 44,284 of potatoes, 14,788 of turnips, 1340 of carrots, and 413 of rye. The farm instructors and their wives make a point of teaching the Indians how to use their spare time. The men are encouraged to make handles for axes and hay forks, besides sleighs, ox collars, harness, brooms, &c. The women are initiated in tanning and butter-making, and already make articles of clothing that would not disgrace a white woman, being particularly quick at knitting; some of them, too, are expert in the manufacture of baskets, mats, and hats. The housing of the people also improves, the Bloods in particular now partitioning their houses into rooms. The trust funds held for the Indians by the Government now amount to £703,046, and £57,098 was spent from this source last year, besides £186,442 voted by

Parliament. Of the Parliamentary grant no less than £164,437 went to the North-West, including Manitoba and Keewatin; while British Columbia took £17,010 of the remainder.

There seems to be no doubt that the aborigines of the Andaman Islands are rapidly disappearing. According to the latest administrative report relating to the islands, all the people of Rutland Island and Port Campbell are dead, and few remain in the South Andamans. Mr. Portman thinks that the present generation of this interesting race will be the last. Only a small number of children are born, and they do not survive infancy.

In his Presidential address to the American National Geographic Society, now printed in the Society's Magazine, Mr. Gardiner G. Hubbard presents an interesting sketch of the forces which have been at work in the evolution of commerce. In the concluding passage he glances at what he supposes to be the future of commerce. America, the last of the continents to be inhabitated, now receives, he points out, the wealth of Asia on the one hand and manufactures and population from Europe on the other. "Here the East and West, different from each other in mental power and civilization, will meet, each alone incomplete, each essential to the fullest and most symmetrical development of the other. Here will be the great banking and commercial houses of the world, the centre of business, wealth, and population."

In ancient times Greece possessed something like seven and a half millions of acres of dense forest, and she was comparatively rich in timber until half a century ago. Many forests have now disappeared, and the result is seen both in the scarcity of the water supply and in various injurious climatic effects. The Austro-Hungarian Consul at Athens—while calling attention to these facts in a recent report, of which some account is given in the *Board of Trade Journal* for April—points out that even at the present day Greece possesses about two millions of acres of forest land. The quantities (in cubic metres) of timber and forest produce obtained in 1890, compared with 1889, were: building wood, 59,948 and 48,986; timber for shipbuilding, 2606 and 1640; for tools and machinery, 4146 and 2940; lignite, 509,895 metric centners, compared with 466,953; asbestos, 491,722 metric centners, compared with 490,179; and tanners' tawing materials, 20,003 metric centners, compared with 30,089 in 1889. Notwithstanding this considerable production, Greece will have to import large quantities of timber in the near future, so as to meet the demand arising from the revival of the building trades now affecting both the rural and urban districts of the peninsula.

A paper on the agricultural needs of India, by Dr. J. Augustus Voelcker, was read the other evening before the Society of Arts, and is printed in the current number of the Society's Journal. It gave rise to an instructive discussion, in the course of which Mr. Thiselton-Dyer—referring to the necessity of India producing sufficient food for its growing population—said the real question was how to get more nitrogen into the soil. That overshadowed everything else. He agreed with Prof. Wallace, who had spoken before him, as to one way of supplying this want. After the studies made in Germany, France, and England, there could be no longer any doubt that the growing of leguminous crops did enrich the soil with nitrogen in a way which, as far as was at present known, without manure, could be done in no other way; but in India the method of green soiling was not altogether unknown. If it were, the sooner some popular account of the method was distributed the better. An old pupil of his own, who had charge for a time of an experimental farm at Bangalore, found that by making some slight addition to the Indian plough he was able to stir the soil—not to plough deeply, but to stir it lower than the ordinary plough did, and, by slightly opening the subsoil in this way, the roots were able to get down lower, and the crops, even in a season of drought, flourished in a way they did not when the soil was cultivated in the ordinary manner. He was inclined to think that the Indian plough was a thing which deserved a good deal of study; but it could not be studied very well by people in Europe, because our conditions were so different. The study should be made on the spot, and efforts should be made to improve the agricultural methods there by the introduction, if possible, of some kind of rotation with leguminous crops. He was under the impression that, in a great deal of the cultivated land of India, there was something like a pan, formed at no great distance below the surface, which made it extremely difficult for the roots to penetrate, and so they were unable to bear even a slight drought.

The Great Bower Bird seems to give the people of Northern Queensland very frequent occasion to think about him. Every kind of fruit suffers from his depredations; and, according to a letter from Mr. E. M. Cornwall, printed in the *Victoria Naturalist*, he has also a taste for new-laid eggs. Says Mr. Cornwall:—"This is not mere supposition, but hard fact, for after noticing the disappearance of eggs in a most unaccountable manner for some time, the gardener kept watch, and was rewarded by seeing Mr. Bower Bird fly straight to a nest just vacated by a hen and deliberately pick the egg and polish off its contents." "*In re* the Great Bower Bird.—Since writing you last, I have had still further evidence to convict this rogue of what I charged him with. A bird was seen to fly right to a hen's nest in an empty shed and immediately emerge with an egg in his long claws; but the egg proved an awkward burden, and he dropped it ere he had gone many yards."

Colonel W. S. Hore gives in the journal of the Bombay Natural History Society (vol. vi., No. 3) an interesting account of the taming of a heron. Writing from Deesa in September 1891, he says that during the then recent monsoon a young egret or heron with a greenish-brown neck and body, white-tipped wings, and green legs, flew into the verandah of his house, apparently in search of food. He caught it, and for about ten days kept it under a large basket, feeding it with raw meat. He then gave it its liberty, but it refused to leave. It grew very tame, and would feed out of Colonel Hore's hand. Occasionally it would indulge in a bath in one of the dog's tins, and afterwards sit on a chair in the verandah. In the evening it flew away to roost in one of the large neem trees in the compound. It showed no fear of the dogs, and would give any of them who came too near a vigorous "dig" with its long bill. It remained with Colonel Hore for about six weeks, when, as his regiment was under orders to march, and he was afraid if left behind it would meet with an untimely end, he carried it down to the river about two miles off and left it there.

The new number of *Petermann's Mitteilungen* has a map of the Kalahari Desert, and the western part of British Bechuanaland, with remarks by Edward Wilkinson. There are also articles on the Pamir question (with map), by F. Immanuel, and contributions to our knowledge of the south-eastern part of Persia, by A. J. Ceyp.

The Rochester Academy of Science, U.S., has published two *brochures* of the first volume of its Proceedings. The papers are attractively printed and well illustrated. Among the contributions we may note "The Aurora," "The Forces concerned in the Development of Storms," and "The Zodiacal Light," by M. A. Veeder; "Description of New Meteorites," and "Notice of a New Meteorite from Louisa County, Va.," by Edwin E. Howell; "Root Foods of the Seneca Indians," by G. H. Harris; "Descriptions of New Species of Muricidæ, with remarks on the apices of certain forms," by Frank C.

Baker; and "Notes on Mexican Archæology," by F. W. Warner.

MESSRS. WM. BLACKWOOD AND SONS will publish, in the course of a few days, a short treatise on "Farmyard Manure," by Mr. C. M. Aikman, Lecturer on Agricultural Chemistry, West of Scotland Technical College.

MESSRS. SMITH, ELDER, AND CO. have issued a third edition of the "Junior Course of Practical Zoology," by Prof. A. Milnes Marshall, assisted by Dr. C. Herbert Hurst. Advantage has been freely taken of corrections and suggestions received from many sources. The whole book has been carefully revised, and some new figures have been added.

THE Royal University of Ireland has issued a supplement to its Calendar for the year 1892. It includes the examination papers used in 1891.

A NEW series of compounds, in which the hydroxylic hydrogen of phenols is replaced by the element titanium, are described by M. Lévy in the April number of the *Annales de Chimie et de Physique*. The first member of the series, that derived from the simplest phenol, carbolic acid, C_6H_5OH, possesses the composition $TiO_4(C_6H_5)_4$ or $Ti(C_6H_5O)_4$. The discovery of these somewhat remarkable compounds was the result of an investigation concerning a colour reaction of titanic acid. M. Lévy had observed that when a small quantity of titanic acid was brought into contact with sulphuric acid containing a little phenol, a deep red coloration was produced. The red colouring matter was soluble in the oil of vitriol, but was decomposed when the solution was diluted with water or neutralized by alkalies. The red substance has, however, been isolated by employing another mode of preparation, and proves to be the titanium phenylate, $Ti(C_6H_5O)_4$, above mentioned. It may readily be prepared by the action of titanium tetrachloride, $TiCl_4$, upon a solution of phenol in benzene. The titanium tetrachloride, in quantity one molecular equivalent, is poured directly into the solution of four molecular equivalents of phenol, when a very energetic action occurs with liberation of a large quantity of hydrochloric acid gas. The last traces of hydrochloric acid are removed by means of a current of hydrogen, the reaction flask being warmed to about 70° by means of a water-bath and fitted with a reflux condenser. Upon the completion of the reaction the benzene is evaporated off, when the new compound is left behind in the form of large crystals. The crude substance thus prepared is then recrystallized from a mixture of benzene and petroleum, when it is obtained in the form of rhombohedral crystals of the colour of bichromate of potash, and which, like the latter compound, yield a powder much yellower in colour upon pulverization. The crystals are readily soluble in benzene, toluene, alcohol, or ether. They also dissolve in concentrated sulphuric acid, producing the same red oil which is formed in the colour reaction above described. The action of water upon the crystals of titanium phenylate appears to be of the nature of saponification. It occurs in at least two stages, a compound $TiO_4H_2(C_6H_5)_2$ being first produced; this intermediate compound passes eventually into titanic acid, carbolic acid being at the same time formed in the solution. Fuming nitric acid, when in large excess, converts titanium phenylate into titanic and picric acids; but if only a small quantity of nitric acid is employed, titanium picrate is precipitated in the form of a black insoluble substance. Nascent hydrogen, liberated by means of dilute hydrochloric acid and zinc or tin, reduces the titanium in titanium phenylate to titanium trichloride, with production of the usual violet coloration due to that compound. Gaseous chlorine rapidly converts the crystals of titanium phenylate into titanium tetrachloride and the di-chlorine derivative of phenol. In addition to titanium phenylate, the analogous compounds with the cresol phenols, thymol, naphthol, resorcinol, and salicylic acid have been prepared. They are all red or brownish-red solid substances possessing properties similar to those of titanium phenylate.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo-viridis* ♂) from North-east Africa, presented by Miss G. A. Vicars; a Leopard (*Felis pardus* ♂) from Ceylon, presented by Mr. Marcus W. Millett; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by Mrs. Kate Taylor; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. Earle Whitcombe; a Common Zebra (*Equus zebra* ♀) from South Africa, a Wonga-wonga Pigeon (*Leucosarcia picata* ♀) from New South Wales, a Cereopsis Goose (*Cereopsis novæ-hollandiæ*) from Australia, deposited; a Yak (*Poëphagus grunniens* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMY AT THE PARIS ACADEMY, APRIL 11.—MM. Périgaud and Boquet have independently made some observations of the latitude of Paris Observatory, one of the objects of the investigation being to determine whether the value underwent a periodic variation. The two series of observations only differ from one another by about one-hundredth of a second of arc; the value derived from them is 48° 50′ 11″·01. No definite evidence of variability was obtained. Admiral Mouchez, in commenting upon these observations and a discussion of the latitude of the Observatory, made by M. Guillot in 1879, said that doubtless the variation found at other Observatories was wholly or in large part due to the influence of temperature on astronomical refraction. A photograph taken by Dr. Gill was presented by Admiral Mouchez to the Academy. It embraced an area of 2° × 2°, and on this sky-space from 30,000 to 40,000 stars had left their impressions, besides two nebulæ. The exposure given was 3h. 12m. instead of the 1h. which is given to plates for the "Carte du Ciel." If this exposure were possible for the whole photographic map of the heavens, about 300,000,000 stars would record their existence instead of 30,000,000.

Swift's and Denning's comets have been observed at Bordeaux on several occasions. The former is described as very brilliant, with a nucleus of about the seventh or eighth magnitude, a head about 8′ in diameter, and the trace of a tail. M. Landerer has compared the calculated time of eclipses of Jupiter's satellites given in the *Connaissance des Temps* with the actual times observed. The agreement between the two is very remarkable.

SOLAR HEAT.—Volume ii. of the Transactions of the Astronomical and Physical Society of Toronto (1891) has recently been issued. It contains several interesting papers, one of which, by Dr. Joseph Morrison, deals with solar heat. Two theories have been advanced to account for the source and maintenance of the heat of the sun. One ascribes the heat to the energy of meteoritic matter falling on the sun, the other asserts that the supply of heat is kept up by the slow contraction of the sun's bulk. Taking the "solar constant" as twenty-five calories per square metre per minute, Dr. Morrison calculates that the linear contraction of the radius of the sun which is requisite to keep up the present rate of radiation, is 0·000004972 feet in 1 second, or 156·9 feet in a year, or 29·716 miles in a thousand years. "Now 450 miles of the sun's diameter subtends at the earth an angle of 1″, and therefore it would require 7575 years for the sun's angular diameter to be reduced by 1″ of arc, which is the smallest angle that can be accurately measured on the solar disk." With regard to the meteoritic theory of solar energy, a calculation shows that a quantity of matter which weighs one pound falling freely from infinity to the sun would develop by its kinetic energy 82,340,000 units of heat. From this it can be found that the heat radiated could be developed by the annual impact on the sun of a quantity of meteoritic matter a trifle greater than 1/100th of the earth's mass, and having a velocity of 382·6 miles per second.

PERIODIC VARIATIONS IN LATITUDE.—Mr. Chandler, in some recent numbers (248 and 249) of the *Astronomical Journal*, announced the discovery that the earth's axis of rotation revolves round her axis of maximum moment of inertia in a period of about 427 days. In the *Monthly Notices* for March, Prof. Newcomb contributes a paper on the "Dynamics of the Earth's Rotation," in which this result is mentioned with reference to the periodic variations in latitude. By dynamic principles the ratio of such a rotation to that of the earth's revolution "should be equal to the ratio of her polar moment of inertia to the difference between the equatorial and polar moments." This gives a time of rotation of 306 days. Mr. Chandler's result, as Prof. Newcomb says, "at first sight seems in complete contradiction to these principles," and he is led to inquire into the theory which assigns the time of rotation. The present paper is the result of such an investigation, and he finds that two defects have made themselves apparent—"namely, the failure to take account of the elasticity of the earth itself, and of the mobility of the ocean." If the earth be considered first of all to be rotating as a homogeneous spheroid covered by an ocean of the same density as itself, the axes of rotation and figure would of course be perfectly coincident. By supposing a slight displacement of the axis of rotation of $0''\cdot20$ in the case of our earth, he estimates approximately one-fourteenth of this as the movement of the axis of figure in consequence of the shifting of the ocean. As two-sevenths are required by Mr. Chandler's results, "the ocean displacement only accounts for one-fourth of the difference." Since the remainder must be attributed to the elasticity of the earth, he inquires into the rigidity that our planet must have, so that the displacement of the axis of figure may be two-sevenths that of the axis of rotation: the result of the inquiry is to find that a rigidity greater than that of steel must be assigned to it. The effect of viscosity, he mentions, makes the normal pole move slowly and continuously towards the revolving one, so that in time they would meet if they were not acted upon occasionally by some opposing forces. The pole of rotation, according to Chandler's period, makes six revolutions in seven years, and Prof. Newcomb investigates the effect of an "annually repeated cause" that might produce such a change in the position of the earth's axis. This effect, as he points out, would be cumulative for one-half the period of seven years, and as the displacement is small, a comparatively minute disturbing force can be looked for. Basing his calculations on Chandler's period, he finds that such an effect can be obtained, for, "if the winters in Siberia and in North America occurred at opposite seasons, we should have no difficulty in accepting the sufficiency of annual falls of snow to account for this anomaly."

RECENT ADVANCES IN PHYSICAL CHEMISTRY.[1]

IN its course of development from a descriptive into a rational science, chemistry has, in a tolerably regular series of changes, passed in turn through periods of more special and of more general interest. While the gathering together of empirical facts proceeds in quiet, steady work, little troubled by minor and rapidly decided differences of opinion, it is regularly noticed, upon the other hand, that more generalizing ideas, brought forward for the purpose of a rational comprehension and unifying of this material, obtain only in the rarest cases a kindly, immediate reception. On the contrary, the reaction which such things at first call forth is almost always a more or less violent opposition, its precipitate is to be sought out upon the filter of the scientific literature of the time, there coming afterwards to our view, in the text-books, only the clear filtrate of the pure results. This has scarcely ever appeared more strikingly than in the fall of the phlogiston theory: the periodicals and books of the last century resound again with the strife of the opponents, and often enough were the moral qualities of the newer party attacked when the opposed arguments became threadbare; whereupon from the attacked party a corresponding reply was never lacking. The intellectual combat died away but slowly, until the new territory was occupied in common in peace and harmony. We have lived through a similar experience in the change from the electro-chemical theory to the substitution-theory, in the transfer from the idea of equivalents to that of molecular quantities, in the transformation of the radical theory into the theory of types and structure. Even the younger men among us remember the strong opposition with which was greeted at its first appearance that idea of the arrangement in space of the atoms in molecules, which now occupies so many investigators.

So it is a bloody field, whose present condition I have undertaken to represent to you to-day. Do not fear that I shall bring the uproar of conflict into this hour of peaceful looking backward and forward. I have rather called up these recollections in order to awaken in you the consciousness that this strife, which has indeed not been wanting in the more recent years of the development of general chemistry, is no abnormal phenomenon, possibly called forth by an unusual inferiority of the newly appearing general ideas or of their defenders, but that it is only a question of the normal birth-pains which unavoidably accompany the appearance of important generalizations.

But before taking up connectedly these newer and newest things, it will be in place to cast a glance over the development of those fields whose progress has been of a steady nature.

First, as concerns the atomic weights. The investigations which have been carried on for some years by American and English investigators—Cooke and Richards, Morley, Lord Rayleigh, Noyes, Dittmar, and others—upon the relation between hydrogen and oxygen, have not yet been brought to a close. While most of the determinations have united to indicate that the ratio of the atomic weights of these elements is 1 to 15·87, thus differing about 0·8 per cent. from the previously assumed value 1 to 16·00, yet by means of a well-thought-out method, Kaiser has found first 15·945, while he has now just announced that the most probable value is the old 1 to 16·00. It is remarkable that the efforts of so many investigators to determine this fundamental constant accurately to within one part per thousand have not yet met with a generally-accepted success.

In this connection are to be mentioned the discussions, which have been held upon the question as to the practical unit for the atomic weights, whether $O = 16\cdot00$ or $15\cdot96$ should be employed. This is not the place to test the grounds adduced on both sides. Perhaps it may be possible, with the present stricter organization of our Society, to form a commission which shall subject the question to a general examination, and which, by the standing of its members, shall be endowed with sufficient authority to insure to its decision some prospect of general acceptance.

The question as to the connection and significance of the numerical values of the atomic weights has made no progress of importance since the fundamental researches of Lothar Meyer and Mendeleeff. Indeed, speculations do not cease in the direction given by the assumption of a compound nature of the elements, yet I know of none for which I could dare prophesy growth and development. Steady work in the revision of the numerical values of the atomic weights has been patiently prosecuted. I need mention especially only the close of the researches of the untiring Seubert upon the metals of the platinum group; and we should recognize with great thankfulness the devotion with which this work, so thankless in itself, has been carried through.

No new elements of importance have come recently to light. Although in the garden of the "rare earths" many a blossom has appeared, there fail as yet any real fruits.

In the theory of gases the investigations continue according to the general equation of condition (*Zustandsgleichung*), in that the recognition is steadily breaking its way, that the nearest entrance to the theory of liquids leads necessarily over the critical point. The kinetic hypothesis, which was greeted in its time with so much sympathy, and has enjoyed such careful attention, is showing itself here essentially unfruitful, since the two main principles of the theory of van der Waals, to which the immediate future undoubtedly belongs, are independent of the kinetic hypothesis. In fact, neither the assumption that only the space which is *not* filled with the substance of matter follows Boyle's law, nor the assumption that this matter possesses still some energy of reciprocal action, necessitates any definite representations whatever in the sense of the kinetic hypothesis.

Among the experimental researches upon these relations are especially to be mentioned those of Ramsay and Young. The relation determined by them, that within a very wide range the equation $p(v - b) = fT$ is true, or that the co-volume, b, is independent of the pressure, is one of the few general facts which are leading us to a more accurate knowledge of the general equation of condition.

In solving the task of finding a theory of the liquid condition, we shall have to seek other properties, which show themselves to be here subject to the more simple laws. As yet but few

[1] Address delivered before the united Sections of Physics and Chemistry at the yearly meeting of German Men of Science and Physicians at Halle, September 24, 1891, by Prof. W. Ostwald, Ph.D., of Leipzig.

such have become known, and still fewer have been considered in this manner. In addition to the above-mentioned result of Ramsay and Young, there claims attention one discovered by the Hungarian physicist Eötvös, according to which the *molecular surface energy*, as expressed by the product of the capillary constant and the $\frac{2}{3}$rd power of the molecular volume, is shown to be a linear function of the temperature. Since the surface energy stands in closest connection with the energy of interaction, by virtue of which the substance of liquids, in contrast to that of gases, assumes its own proper volume, and to which is accordingly due the characteristic existence of the liquid condition, it becomes at once evident that here certainly a means of access to the theory of the latter is afforded. This means may be expected to lead more rapidly to the goal than the methods hitherto almost exclusively tried, based upon a relation between volume, temperature, and pressure.

The stöchiometry of the liquid organic compounds, founded by Hermann Kopp, has enjoyed likewise a steady development. While the question of the boiling-point seems to be essentially postponed until the general theory of liquids becomes known, yet that of the molecular volumes has reached a stage which already assures the prospect of a successful period of development. The additive scheme, proposed by Kopp as a first approximation, according to which the molecular volume is the sum of the atomic volumes—a scheme whose insufficiency Kopp himself had shown in the case of oxygen—determines only the roughest outlines of the phenomenon in question. Other factors make themselves everywhere felt; as was shown by Kopp for oxygen—that the portion of the molecular volume due to it can assume different values according to the function of this element in the compound, *i.e.* according to the constitution of the molecule—so the same holds for the other elements. An essential difference between univalent and bivalent elements is, in this respect, not present: ethylene and ethylidene chlorides have different molecular volumes, although they both contain saturated carbon atoms, and, in addition, only univalent elements.

We must, accordingly, more than ever before, recognize the molecular volume as a constitutive property. This recognition removes at once the firm barrier to which the additive scheme, greatly against the will of its originator, had hardened. In vain had been for so long striven to force the facts into this form; ever and again their living body would not fit upon the wooden cross. Now we see that this undertaking was *necessarily* in vain: we begin to comprehend that methyl alcohol must be more different from ethyl alcohol than ethyl alcohol from propyl alcohol; and that these two, again, must stand in a different relation than do propyl alcohol and butyl alcohol, although each time the "same" difference of CH_2 is at hand—that there are, in short, no two pairs of compounds whose differences are entirely the same.

Now, it is quite dependent upon the nature of the property considered, in what relation the additive foundation stands with the modifying effect of constitution. With the molecular volume the first is comparatively superior; with the boiling-points, however, the latter make themselves to the most superficial observation so energetically felt that, since the attempts of Schröder, Löwig, and others, which over fifty years ago failed to carry through the additive scheme for the boiling-points of organic compounds, this line of effort has been definitely given up. The other properties which have been studied fall between these two limits.

This holds especially for the molecular refraction. Just as Buff had earlier shown that "double bound" carbon possesses a greater molecular volume than does saturated carbon, it has been demonstrated by Brühl that a similar relation holds for the molecular refraction. This influence of constitution is, however, not the only one; a similar inference has been shown for oxygen and likewise for chlorine, and it has been repeatedly shown that, even if approximately additive laws be followed among the higher members of homologous series, yet these do not apply for the first members. This is necessarily so, as has already been shown in discussing molecular volumes.

The magnetic rotation is a property of much more strongly marked constitutive character than are molecular volume and molecular refraction. We possess here most excellent investigations by Perkin, which have often been found of service in determining questions of constitution.

In relation to the connection between the different properties of substances a fruitful line of thought has been carried out by Philippe-Guye. As is known, Maxwell had derived a definite relation between the coefficient of refraction and the dielectric constant, from his wide-reaching speculative investigations, which latter had yielded a complete analogy of the mathematical expressions for electrodynamical and optical action at a distance, together with an approximate equality of the fundamental constants, and which have been finally made fruitful by the brilliant experimental investigations of Hertz. This dielectric constant is in turn, according to an expression due to Clausius, a simple function of that fraction of the total volume of a dielectric which is occupied by the actual material substance (considered as conducting). But this so called true molecular volume is, finally, nothing but the co-volume in the equation of Van der Waals. There is accordingly to be expected a close connection between the critical constants and the molecular refraction, and Guye has shown that the expected connection actually exists.

Although spectrum analysis, with its manifold applications, has for years had almost no rational development, it has recently taken a quite promising start in the stöchiometric direction. The theoretical and experimental researches of Balmer, Deslandres, Julius, Rydberg, Kayser and Runge, and others, indicate already that the time is not far distant when there shall be simple and intelligible regularities in this field, which until now has been so overgrown with unfruitful hypotheses. Only upon one point I wish at this opportunity, as a chemist, to direct the attention of the physicists. It is held as an undoubted dogma that at the highest temperatures, as, for example, in the electric light arc, all compounds must be dissociated into their elements. This view is certainly not justified. What we do know about the stability of compounds is, on the contrary, that all compounds which are formed with absorption of heat become *more stable* with rising temperature, and the reverse. Because the majority of the compounds known to us are formed from the elements with evolution of heat, and correspondingly become more unstable with rising temperature, the conclusion has been drawn that this is in general the case. But if we reflect that cyanogen and acetylene, two compounds formed with great absorption of energy, are readily formed in quantity, at the highest temperatures, in the blast-furnace and in the Davy arc light, we become conscious that the spectra occurring at high temperatures may, under proper conditions, belong to compounds which, formedu with great absorption of energy, may have a fleeting existence confined to those temperatures only. From this point of view, many difficult facts of spectroscopy and spectrometry would have some prospect of a proper interpretation.

At the extreme boundary of the optical properties, towards the side of the constitutive character, stand finally colour and rotation of the plane of polarized light. Although the first property is decisive for one of the most important branches of technical chemistry, the dye-stuff industry, still but little is known as yet about the connection of colour with composition and constitution. The investigations of Krüss, Liebermann, and more recently Vogel, all indicate that the property is in great measure constitutive, becoming additive only within the narrowest limits of closely-related compounds. This renders correspondingly difficult a recognition of the connections at hand. Some time later, on the contrary, directly on account of this marked constitutive character, the colour will be an important aid in the determination of constitution; at the same time, when we shall have learned to recognize this connection with some certainty, the discovery of new dyes with definite properties will be no longer a matter of a lucky hand and of an unconscious feeling for this connection, but will rest upon just as broad a basis as, for example, the technic of the metallurgical processes.

The constitutive character of the rotation of the plane of polarization has been always known and recognized. Since van 't Hoff and Le Bel, twelve years ago, pointed out the connection between this property and the presence of an "asymmetrical" carbon atom, *i.e.* one joined with four different elements or groups, this idea has, at first slowly, then more and more rapidly, had an important development. For the "optical symmetry" shown by Pasteur in the tartaric acids, the examples have become more and more numerous; the researches of Wallach on the ethereal oils have especially furnished valuable material. The presence of optical activity is now held as an entirely undoubted proof for the presence of asymmetrical carbon, and Le Bel has just announced that he has succeeded in the preparation of optically active nitrogen compounds containing an asymmetrical nitrogen atom.

The investigator whom we have already mentioned, Philippe-

Guye, has made a remarkable attempt to find laws for the numerical values of the molecular rotation, by giving to the asymmetry of the carbon atom a numerical measure dependent upon the masses joined thereto, and, in cases of analogous compounds, comparing this with the values for the molecular compounds. While this attempt has been well supported by a number of older measurements, especially those of Pictet on the esters of the tartaric acids, yet his own determinations on the active amyl derivatives have not indeed furnished much very favourable evidence. He has not overcome the difficulties of obtaining pure material, and certain facts were observed contradicting the assumption that the sense of the asymmetry is due to the *masses* added. It is not improbable that this difficulty will be overcome by placing the optical *moment*, if I may be allowed the expression, not proportional simply to the mass of the atom; there is rather to be suspected a connection with the atomic refraction.

We turn now to a field whose development belongs entirely to the last few years, to that of *solutions*. If we call to mind the old saying, *Corpora non agunt nisi fluida, vel soluta*, we perceive at once the very great importance of the field; all rational knowledge of chemical processes must be preceded by a corresponding knowledge of the condition of dissolved substances.

I do not need to remind you that van 't Hoff's discovery of the identity of the laws of gases with those of dissolved substances, is to be characterized as the greatest step forward which has been made in this direction. If we reflect that the development of the molecular idea, which rules the chemistry of to-day, is most decidedly based upon the laws of gases in their simple form, we recognize at once that all the important relations which have been here found can be directly transferred to the domain of solutions. The latter has, however, at the same time, far more varied possibilities in the form of its phenomena. While in the case of gases only two of the variables, pressure, volume, and temperature, are independent, there is present for solutions the manifold infinity of the non-miscible and partially miscible solvents. To this is due the appearance of a great number of new formal and numerical relations for solutions, even under assumption of the simplest form of the governing laws, whereby a rich field of inexhaustible fruitfulness is made accessible to investigation. In fact, after this advance by van 't Hoff, the theoretical investigations of Planck, Riecke, Lorenz, van der Waals, and Boltzmann, as well as the progressive combination of theory and experiment by Nernst, have shown how varied and valuable are the results to be gained, results whose details I am here compelled to omit.

I wish, at this opportunity, to call attention to one particular point. I have already mentioned that the way to a rational theory of the liquid condition leads from the gases, through their variation from the simple gas laws, and through the critical point, whose constants express in especially simple form the individual properties of the kind of matter in question. Now it is to be expected from the theory of solutions, and it has been demonstrated in detail by O. Masson and W. Ramsay, that upon transition from a dilute to a concentrated solution we observe entirely the same phenomena that appear when the volume of a gas is diminished; there is here also a critical state with its corresponding constants. We thus have here a second way to a theory of the condition of pure liquids, which, by reason of the greater variety of the phenomena, is a far more difficult one than is that first named, but which, however, may in many cases be of assistance where the other fails.

While the already discussed parts of the newly-opened territory are mainly those problems with which physicists have concerned themselves, still its study has not been less fruitful for chemistry in particular, especially for organic chemistry. To the above-mentioned variety of the relations here present corresponds an equal variety of the methods of determination of that most important constant, the so-called molecular weight of dissolved substances. Since the tireless Raoult had shown years ago, in a purely empirical manner, the application of the properties of solutions to this purpose, it was reserved for the theory of van 't Hoff to discover the rational basis of these relations, and thus for the first time to give to wider circles of investigators a feeling of security in the making of such molecular weight determinations. Especial service has been rendered by E. Beckmann in the technical development of these methods; and the Beckmann freezing apparatus and boiling apparatus form at present just as necessary and much used a part of the equipment of a laboratory as formerly the Hofmann apparatus for determining vapour densities.

It has naturally come to pass that, together with the suddenly increased range of molecular weight determinations, our views of the nature of this quantity and of the therewith connected question of valence have undergone a corresponding change. The conception had become gradually rather dogmatically rigid: it was understood to require for each substance only a single absolute molecular weight, the variations observed, for example, in the case of acetic acid, being characterized as anomalies. Molecular weight determinations in solutions have shown that such variations are so extended, and, at the same time, occur so regularly, that they may no longer be pushed aside as anomalies. It is therefore at present generally recognized that a substance may quite well have different molecular weights, standing in the ratio of simple multiples, the most important weight for the chemist being of course the smallest of them.

The consequences connected with van 't Hoff's discovery being so important and wide-reaching, they have had in general a friendly reception, although a few scientific men—not of the highest rank—fearing the little plants cultivated by them to be endangered by the flood of light falling upon them, have attempted a slight resistance. On the contrary, all the uneasiness which is unavoidably connected with important revolutions has been directed against a second idea, which, appearing somewhat later than that of van 't Hoff, removed a fundamental difficulty in the theory of solutions, which had until that time made its acceptance impossible for me. This idea has at the same time shown itself as an aid to investigation to be of unexampled sweep and value. This is the *theory of electrolytic dissociation*, of Arrhenius.

It is certainly to be presumed that the fundamental idea of this theory is generally known. In the aqueous solutions of the electrolytes, the salts, acids, and bases, a greater or less proportion of the dissolved molecules are regarded as split up into electrically charged constituents or ions, which exist in the solution indepently of one another in the same manner as the partial molecules of a dissociated gas. If the van 't Hoff theory be admitted, it must be admitted that in a solution of sodium chloride, for example, almost double as many individual particles or molecules are present as in a corresponding solution of sugar or urea of the same formula weight. The experimental connection of these variations with the fact and numerical amount of the electrical conductivity, first discovered by Arrhenius, and which cannot be denied, furnishes the basis for the second part of the theory of Arrhenius, the assumption of electric charges upon the separated molecular constituents or ions. If now these fundamental ideas are accredited, the remainder follows with directly evident necessity.

The significance of these views becomes apparent upon considering the quite astonishing range of phenomena in the most widely separated parts of physics and chemistry which have received explanation from the theory of Arrhenius in connection with that of van 't Hoff. It is simply impossible in the limits of this address to even enumerate these single applications; I shall, as I think, do better by treating the question from a more general standpoint, and, without speaking in particular of each advance made, sketch in rough outline that field in which both theories have brought or will bring decisive explanation.

Let it be first called to mind that the laws of dissociation were already earlier derived thermodynamically for gases. If, then, in the field covered by Arrhenius, the question be one of dissociation, and the laws of gases do, according to van 't Hoff, hold for dissolved substances, it follows that *the entire theory of the chemical affinity of electrolytes must be yielded by the application of those laws of dissociation*. This means nothing less than that the problem of chemical affinity is in reality solved.

The conception of chemical affinity is to be understood to reach so far as to include all phenomena caused by the so-called inner energy of bodies. It includes, then, not only the processes especially termed chemical, but also those of vaporization and solution without exception as well. If it be wished in the latter case to preserve the ever emphasized but still unclear distinction between "chemical" and "physical" processes, to the former may be reckoned those processes in which electrolytic dissociation comes into question, and to the latter those in which this is not the case. Thus, the dissolving of oxygen in water is in this sense a "physical," that of hydrochloric acid in water a "chemical," process. But this distinction is secondary: it is expressed only in the greater complication of the corresponding formulæ; the fundamental equations remain everywhere the same. In other words, the question is one of the theory of all conditions whereby heterogeneous substances or heterogeneous phases of the same substance have assumed, after reciprocal influence, a condition of equilibrium independent of the time.

The general theory of these conditions has been developed by J. Willard Gibbs sixteen years ago; a German edition of this magnificent and incredibly many-sided investigation is at present in the press. Through van 't Hoff and Arrhenius we are placed in a position to insert in the equations of this man of science, which contain necessarily a great number of yet unknown functions, the expressions for these functions, together with the numerical constants, and to thus solve the problem numerically from case to case.

It must, however, be borne in mind that the functions in question, expressing as the sum of its single forms the total energy of the system considered, are yet known only for the cases of gases and dilute solutions, *i.e.* for the cases where the inner energy has become independent of the volume. As far as the knowledge of the equation of condition reaches, extends the possibility of mastering the heterogeneous conditions and chemical equilibria. And we see at this place how the different parts of general chemistry reach to one another the hand; the solution of the problems which were mentioned in the first part of this address is also, for that just discussed, the unavoidable condition of progress.

But with the range just measured off, great as it is, the limits of the province of the van 't Hoff-Arrhenius theory are not yet reached. The dissociation discovered by Arrhenius is an *electrolytic* one. Accordingly, the immense number of phenomena, in which the electrically charged ions participate, belong likewise with those which here receive a new light. The question as to the source and maintenance of the electrical energy in the galvanic elements, as to the conduction of current in electrolytes, as to the meaning of galvanic polarization, are only single points in this field. Electro-chemistry in the widest sense, and, indeed, as much so that part which is concerned with essentially electrical questions as that which studies chemical questions, has already received most valuable furtherance from our theory, and has yet more in prospect.

It is natural, as against this exposition, to propose the question how the theory of van 't Hoff and Arrhenius has responded to the requirements which have been made upon it in a so extraordinarily wide-reaching and varied manner. Since I belong to the few who make use of this aid in their investigations, I must freely confess that my judgment in this matter may be looked upon as subjective; but since, on the other hand, I hold to both theories unfortunately, not the position of a father, but only that of an uncle of rather distant relationship, you may trust me that at the time of first meeting them I was rather inclined to repel than to greet them. I can then only personally declare that no scientific idea produced in my time has assisted me in such measure as has this one, and that I have further gained the impression that the great scientific fields named have received likewise unusual furtherance from this idea. In particular the extraordinarily manifold and severe test which lies in the numberless numerical consequences of the theory in all possible fields, has yielded such a number of confirmations that the relatively rare cases where the unprejudiced decision was "insufficient" entirely vanish. Naturally must not be considered the judgment of those who, with insufficient qualifications, set themselves up as judges, who do not attempt to test the theory, but only to refute it. The misunderstanding and false conceptions from which such "refutations" proceeded have been in fact of such kind that thereout no real progress, which is the end of every scientific undertaking, has resulted.

I hasten to close. The concise review of the working ground of general chemistry, which I have just attempted to give, shows to what great extent chemistry has made use of physical means to solve her problems. It is, therefore, not especially necessary to urge my chemical associates that they should follow up the study of physics and acquire the necessary mathematical knowledge. It is cared for at many Universities by the more far-seeing teachers of chemistry, that this indispensable knowledge is made as accessible as possible to our youths, and my personal experience has shown me that such opportunities are gladly and profitably used.

But the reverse does not present so favourable an aspect. The science of physics requires for its extension and development exhaustive chemical knowledge in many directions. All phenomena in which the special character of matter comes into question require for their study an extended knowledge of just this character, *i.e.* chemical knowledge. And I cannot avoid complaining that in this direction too little is done. In the more recent physical literature, I have met not seldom chemical views, which were, in short, fearful, and which gave to the interpretation of the observed phenomena an entirely false direction. The physicist is only too inclined to consider chemistry as an inferior science, of which he knows a great sufficiency if, in the early part of his student life, he has once heard its lectures. Nothing can be more wrong than such a view. By reason of its richer and more special store of facts, chemistry really remains behind physics in its development into a rational science, and it will ever so remain, in the same way as physics remains behind astronomy or mathematics. But directly for this reason the beginning of the student years is the only time in which to become acquainted with the varied details of chemical phenomena, and to take up the enormous range of experience here offered. For, according to experience, the physicist never learns them later. The history of our science points out a number of men, who, from chemists, have become physicists of high rank; I need name only Regnault, Faraday, Davy, Magnus, Hittorf. But I cannot name a single man of science who, after having been trained as a physicist, has made one purely chemical discovery of importance, for it never occurs that a physicist *later* learns chemistry. The great range of empirical experience can only be incorporated into the memory at a time when the latter is fresh, and it is usually already too late but a few semesters after the student life has been begun.

I can, therefore, not urge my physical colleagues enough: send your students at first for a few semesters into the chemical laboratory. We chemists must indeed do our part, in suitably rearranging the laboratory instruction; the practice in qualitative analysis should, in particular, be greatly cut down, and in its place preparative work in its widest sense, together with the typical forms of quantitative analysis, should be taken up. But since the same requirements are to be made upon the education of the future teacher of the natural sciences and mathematics in the *Gymnasia* and *Realschulen*, it will not be difficult to soon find the methods best adapted for the chemical education of all non-chemists, without injuring the immediate purpose of the chemical laboratories—the training of chemical specialists.

THE GENERAL CIRCULATION OF THE ATMOSPHERE.[1]

IF the question of the general circulation of the atmosphere were referred to a meeting of educated people, one might be sure that ninety out of a hundred who could give any answer at all would explain it by the time-honoured equatorial and polar current; if anyone initiated in the subject sat near, one would observe a pitying smile upon his lips, and, if asked for his opinion, he would relegate that current, of sacred memory, to the region of the fables, or at most only allow it to hold sway, with certain limitations, in the tropical and sub-tropical zones, the region of the trade-winds; the temperate and cold zones however would be reserved for the dominion of the variable winds, and of newly arisen cyclones and anticyclones, of which we cannot tell whence they come and whither they go, *i.e.* for the origin and disappearance of which we cannot lay down any laws. And if there were several of these initiated persons present, a discussion would at once occur, from which no one could obtain a clear idea, and which would leave everyone with the impression that nothing certain was known about the subject. I suppose that you have been present at such a discussion, and have appealed to me to explain to you the present state of our knowledge of this subject.

I undertake this task the more willingly, since the question of the general circulation of the atmosphere has but recently entered upon a new stage, which marks a great step towards the complete solution of the question, and because it is very desirable to obtain as wide a diffusion as possible for this theory which corresponds to the present state of the science.

In this question especially, as in many others, the history of the development is exceedingly instructive, and of the greatest value in aiding a comprehension of the subject. I propose, therefore, that you should follow me through the different stages

[1] Translation of a lecture delivered by Dr. J. M. Pernter before the Scientific Club in Vienna.

which the explanation of the general circulation of the atmosphere has undergone; little or nothing more will then be wanting in order to understand the answer to the question at issue.

Dove was the first person who advanced a theory of the general circulation of the atmosphere after meteorology took a place among the exact sciences. He considered the question from a high and correct stand-point, because he considered the atmospheric envelope of the earth as a whole, which received its motion from the sun, the universal motor. According to his theory, the explanation of the general circulation of the atmosphere took the following form:—

The heat of the sun is not uniformly distributed over the earth's surface, but decreases from the equator to the poles. The greatest heat occurs at the equator, and the least at the poles. The air which is greatly heated at the equator must consequently rise, an ascending current must be developed there (the celebrated *courant ascendant*). The zone of calms is the region of the ascending air current. The air carried upwards must flow away above towards the poles, while, owing to the rotation of the earth, it endeavours to deviate to the right; the equatorial current is originated as an upper south-west wind, in the higher strata of the atmosphere. The flow of the upper air towards the poles is compensated below by the flow of the air towards the equator, and this polar current seems to be turned away towards the west owing to the rotation of the earth; it appears on the earth's surface as a north-west wind, and blows as far as the zone of calms, where it ceases, and the air brought with it is carried upwards in the ascending air current, where the circulation then begins afresh.

You see that this theory leads to a circulation of the air between pole and equator. The air rises at the equator and flows towards the poles, in order to descend there and to flow again towards the equator. But Dove states expressly that the equatorial current partially descends, even in the temperate latitudes, down to the bed of the polar current. If this happens, and according to Dove this continually occurs, then both winds, the equatorial and polar currents, begin the conflict for the mastery. The variable winds of the temperate zone arise out of this conflict, and Dove deduced therefrom his law of wind gyration. The description which he gave of this conflict of the opposing equatorial and polar currents is a thoroughly masterly picture, and it is in a great measure owing to this elaborate completion of his exposition that his theory of the general circulation of the atmosphere and his law of wind gyration were accepted by scientific men. The reader is carried away by it as if he were present at the conflict of the winds in Æolus's mythological cave, and he is inclined to believe that science verifies the ancient mythology so far as regards the lower latitudes. Dove's theory found an actual support in the trade-winds, and in the law of wind gyration which generally obtains in Central Europe. In fact, in our regions, the wind rotates very frequently from east through south to west and north. Dove's explanation of this, the conflict of the equatorial and polar currents must have appeared to be correct as long as no more serious investigations existed.

Since 1863, weather telegraphy and synoptic weather charts have led to the discovery of the baric wind law (Buys Ballot's law), and the position was at once changed. We learned that the winds depend upon the differences of pressure which prevail over the region under consideration, and that they circulate round the place of lowest pressure; *i.e.*, with us, they flow to the place of lowest pressure, in spirals opposite to the movement of watch hands.

It was now said that the cause of the winds in our latitudes was not the great heating of the air at the equator, but the differences of pressure which were formed in the temperate zone. The law of wind gyration also became untenable. It was found that the swirls which arose about the place of lowest pressure do not stand still, but move, and it was seen that Dove's law of wind gyration for places which lie northwards of the tracks of these swirls does not hold good, in fact that the rotation is exactly the reverse.

The reason why Dove's law of wind gyration mostly holds good in Germany and Central Europe, was found to be that the tracks of the swirls almost always lie to the northwards of Central Europe, and therefore the law must hold good there. But as often as a swirl moves more southwards all places in Central Europe which lie to the north of it have a wind rotation which is opposed to Dove's law.

The equatorial and polar currents, so far as regards the higher latitudes, were thus driven off the field, and the conflict between them, so beautifully described, was again relegated to the mythical cave of Æolus. As it was feared that the wheat might be thrown away with the chaff, it was wished that the equatorial and polar current should be banished from the higher latitudes altogether, but left, in a more limited sense, only in the regions of the trade-winds—between the zone of calms and about 30° north and south latitude; for here it was clear that Dove's theory held good. People unceremoniously denied the right of the polar current to blow beyond the 35th parallel, for in this latitude, as observations show, a band of high pressure encircles the whole earth, while from there the pressure decreases both towards the equator and the poles. But according to the baric wind law the wind can only flow from a place of higher to one of lower pressure; the air can therefore only flow from the 35th parallel towards the pole, and not the reverse. The polar current was thereby banished without mercy from the higher latitudes. The equatorial current fared somewhat better in the upper regions. Many persons allowed it to remain in a small degree, especially those who recognized the accuracy of the calculation according to which in the higher atmosphere, about 4000 m. and over, the pressure decreases from the equator to the pole. But very few persons knew what to make of this equatorial current in the upper regions, and so at all events it was little regarded. Generally speaking, the *régime* of cyclones and anticyclones was established for the higher latitudes, and people were completely absorbed in investigating the details of their qualities and tracks, without having hitherto succeeded in obtaining a satisfactory explanation of their origin and development. With regard to the propagation of cyclones, it was observed that with few exceptions they advanced from the westward to the eastward. Gradually, opinions became general that it was the south-west and west wind of the upper regions which brought the cyclones with it; some persons explained this west wind in the upper regions as the equatorial current. But, on the whole, the general opinion of this period favoured the rejection of Dove's polar and equatorial current, and the explanation of all winds by the prevalent differences of pressure, without being able to account for the origin of the latter.

Dove was of an excitable temperament, and he strongly combated these new views, and laid too much weight on the defence of the defective portion of his theory. His contest was fruitless, and only caused him to be accused with some justice of hindering the progress of meteorology by his great authority. Dove at length remained silent, and the funeral anthem of the polar and equatorial current was then chanted.

Mühry, a well-known meteorologist of the Dove school, survived him, and constantly raised his voice in favour of Dove's equatorial and polar current; he attentively followed the progress of meteorology until his death, a few years ago, and the way in which he frequently warned meteorologists against entirely excluding the equatorial and polar current from their considerations is quite stirring. He was continually trying to turn attention to it, but with him disappeared the last defender of Dove's theory.

But while meteorologists were almost exclusively concerned with the details of the phenomena offered by cyclones and anticyclones, and almost lost sight of the great problems which the consideration of the general circulation of the atmosphere affords, a revolution was being prepared, at first only individually, but gradually more generally, which disposed minds to the more favourable consideration of the general movements of the atmosphere.

More than thirty years ago, Ferrel, the great American meteorologist, was occupied with the question of the general circulation of the atmosphere. He developed its laws in a mathematical form, and arrived at the following theory:—

Three great zones of calms exist round the earth, one at the equator (or near it), usually called the calm-belt, the second and third 35° north and south of the equator, the so-called "horse-latitudes." Between the calm-belt and the horse-latitudes, the north-east or south-east trade-wind prevails at the surface of the earth, and in the higher regions above them the anti-trade (south-west or north-west). In the calm-belt, in which no other than an ascending movement of the air exists up to the greatest heights, an upheaval of the air occurs, and in latitude 35° a descent of the same. Northwards of 35° N., and southward of 35° S., south-west and west winds prevail both at the earth's surface and at great altitudes, while at a mean height a return north-westerly current prevails. The heat of the sun, or difference of temperature between equator and pole, is the cause of this general circulation of the atmosphere, as Dove maintained; the deviation of the wind from the direction of the meridians arises from the rotation of the earth.

This whole theory of the circulation of the atmosphere, which Ferrel deduced by mathematical means, differs considerably from Dove's, but shows that Dove's fundamental idea was sound and worthy of respect.

Ferrel's investigation certainly remained long unknown in Europe, and when at length it became known, it was only received with a purely theoretical interest. It seemed to have no connection with the present almost exclusively interesting question of the origin, development, and propagation of cyclones, and so it was in fact set aside; although from that time people frequently referred to it, and began to pay more attention to the currents of the general circulation. But it was only in 1885 that Sprung in his treatise on meteorology could write: "And so the conviction is now often expressed that we have gone too far in accrediting the individual systems (cyclones and anticyclones) with the sole control over the motions of the air in higher latitudes"; and he then sets up a system of general circulation based on the same principles as those of Ferrel. Sprung's system corresponds tolerably well to Ferrel's, but he also finds in the trade-wind zone that the wind direction at a mean height deviates from the direction of the trade, namely south-east, over the north-east trade-wind. At great heights the westerly winds prevail from the equator to the pole, without passing to calms in the horse-latitudes. At the equator there exists an actual conical calm-zone pointing upwards, in which only ascending air-currents prevail up to the highest altitudes.

Although, owing to the esteem which Sprung's treatise everywhere found, this theory of the general circulation of the atmosphere continued to spread, it did not arouse great interest, because it did not take special account of the influence of these general currents on the formation and propagation of cyclones, which justly continued to attract the most general attention.

This influence of the general atmospheric circulation was first insisted upon by the celebrated physicist and mechanician, Werner Siemens, in 1886. He considered the origin of the general circulation of the atmosphere from the great and fruitful principle of the conservation of energy.

Siemens introduced his far-seeing considerations with the remark that, even if Dove's theory of the general circulation of the atmosphere, which consisted of the ascending air-current at the equator, and the development therefrom of the equatorial and polar current with its conflicts for mastery in the temperate zones, were defective, yet this explanation was at all events more satisfactory than the "present almost exclusive reference of the motions of the air in higher latitudes to minima and maxima of pressure." He rightly asks that the seat of the forces—which accumulate, in a manner that is not at present evident, powerful energy in the cyclones and anticyclones which produce storms and whirlwinds—and the point of their attack may be indicated. Siemens makes no new assertion when he attributes all the energy which occurs in cyclones and anticyclones to the heat of the sun, but he discusses in a new and very noteworthy manner the way in which the sun's heat produces the storms of our latitudes.

Siemens explains the general circulation of the atmosphere according to the following principles:—(1) Without the heat of the sun the earth's atmosphere would be in a state of relative repose, *i.e.* it would everywhere rotate with the angular velocity of the earth's rotation; we should have no winds. (2) In reality, the earth and its atmosphere are unequally heated, most at the equator and least at the poles; consequently, air currents must arise from the equator towards the poles. (3) The energy which is accumulated by the rotation of the atmosphere about the earth's axis must, however, remain constant and unchanged; the theory of the conservation of energy requires this. If, therefore, a continual change of the geographical position of masses of air takes place through equatorial and polar air currents, it must take place so that the velocity of rotation of the whole atmosphere remains unchanged. This is only the case when the velocity of rotation of the whole atmosphere over lower latitudes lags behind that of the earth, but in higher latitudes outstrips it.

It is evident from this that anywhere in middle latitudes, both north and south, there must be a belt round the earth where neither a retardation nor an acceleration occurs, *i.e.* where the air is in relative repose with regard to the earth. Siemens calculates the position of this belt to be at latitude 35°.

According to Siemens, therefore, we have the following system of air circulation:—

Between latitude 35° N. and 35° S., the general movement of the atmosphere is directed towards the west, *i.e.* east winds constantly prevail there in all latitudes and at all heights. In the vicinity of the equator, where north-east and south-east trades meet, an interference occurs at the *surface of the earth*, which produces the calm-zone, but it does not reach to any considerable height. In the higher regions above the calm-zone, an east wind must likewise prevail.

In the higher latitudes, therefore, northward and westward of the 35th parallels, the general movement of the atmosphere must be directed towards the eastward, and west winds must generally prevail in these latitudes.

Now, what do direct observations say to this system of the general circulation of the atmosphere?

There is no doubt that between the 35th parallels an easterly air current prevails, viz. the trade-winds. It is also known that west winds prevail in the higher latitudes, and in the southern hemisphere they blow almost uninterruptedly. But Siemens's theory is not to be considered as proved by these general facts, although they are fully borne out in Ferrel's and Sprung's explanations; we must examine what is new in it more closely. Siemens's exposition requires an easterly air current at the equator, and even in the upper regions above the calm-zone. Does this exist? Until a short time ago, it was undoubtedly the general opinion of meteorologists that the calm-belt was a zone of actual calms up to the highest altitudes, and that only the slowly ascending current prevailed there; in the vicinity of the calm-zone, the trade-wind blowing below ought to rise, and with increasing height gradually assume a poleward direction, to appear soon as an upper south-west trade-wind. This theory, which had become rooted by custom and time, was upset by Siemens: between the 35th parallels there are only easterly currents—the strongest and most purely easterly over the calm-belt, and decreasing continually towards latitude 35°; in the upper regions, on approaching latitude 35°, these currents come continually more from the south, and at the earth's surface more from the north. This was then a serious revolution in the theory of the general circulation of the atmosphere, which even the great authority of Siemens could not carry through without further experimental proofs. He had not reduced his investigations to a mathematical form, and so his theory, notwithstanding the great respect due to his name, would with difficulty have obtained greater success, if facts had not recently become known, which appeared to confirm it.

It is known that after the Krakatão eruption, in the year 1883, the opinion was expressed that the frequent coloured phenomena of the sun in the tropics and the long evening glows were regarded as consequences of this eruption. The spread of these phenomena in the first ten days after the eruption was such that we were obliged to assume that the dust-haze thrown out had travelled round the earth in about twelve days from east to west; for the explanation of the diffusion of these phenomena, a violent easterly wind was required in the upper regions of the atmosphere in the vicinity of the equator. For a long time it was this easterly wind which threw doubt upon the whole hypothesis of the unusual appearances which were referred to the Krakatão eruption. But Siemen's theory of the general circulation of the atmosphere was thereby confirmed. It appeared, however, as if here two hypotheses happened to mutually support each other, and it was a long time before on the one hand the Krakatão hypothesis, and on the other Siemens's theory, were regarded as established.

This theory found however further support—on one hand in the observations of the motion of high clouds by Abercromby, and on the other in the mathematical establishment of Siemens's statement by Oberbeck.

In 1885, Abercromby, during a voyage from Aden to Australia, had observed that in the neighbourhood of the equator the cirrus moved from the east. He was much surprised at this, and wrote: "The discovery of an easterly current over the north-west monsoon is not only altogether new, but also quite anomalous." He thought this so important, that he undertook another voyage from Mauritius to Bombay, in order to clear up the matter. The result of his further observations is couched in the following terms: "I may point out another very important result of these observations—namely, that the highest air current between the equator and the doldrums is always from some point near east."[1]

Here, then, was another actual confirmation of Siemens's theory. Two facts—the diffusion of the Krakatão dust, and Abercromby's observations—supported Siemens's theory of air circulation, yet doubts were not quite removed. Voices were loud against the Krakatão hypothesis and against Abercromby's observations, which allowed another explanation to appear possible. Meteorologists delayed mostly to accept Siemens's theory, because a theoretical, mathematical establishment of it was still lacking. But this was given, as before observed, by Oberbeck, a year or so ago. He arrived at formulæ by which Siemens's theory could be reproduced.

Now, in fact, nothing more was wanting. Siemens's system was confirmed on all sides, by facts and by mathematical treatment. The chief merit for this is certainly due to Oberbeck. Before I bring to your notice the system of the general circulation of the atmosphere, such as it is given by the present state of research, I must allude to one other point in Siemens's exposition—namely, the influence which the general circulation of the atmosphere should have on the origin of cyclones and anticyclones in our latitudes.

The origin of the maxima ought to be due to the fact that the air flowing from lower to higher latitudes is checked in consequence of the convergence of meridians, and so produces an increase of pressure. Thus we get the maxima, or anticyclones. If, then, in consequence of this increase of pressure below, air flows out laterally, and, in consequence of the interference, the confined current turns more to the eastward, it must carry the lower strata with it, and give rise to a rarefaction, causing a minimum or cyclone. But this is carried away as a whole by the general current, and thus the progression of cyclones is also explained.

Siemens holds very strongly to this explanation, principally because it contains a force which explains the energy which is accumulated in anticyclones and cyclones, and which refers finally to the heat of the sun, that maintains the general circulation. But I fear he has overshot the mark here. The meridians converge in the southern hemisphere the same as in the northern. Why, then, do almost constant west winds prevail there below, without interference of currents, while with us an almost uninterrupted system of driving cyclones and anticyclones exists? Does not this prove that in the formation of cyclones and anticyclones another factor is at work, and might not this perhaps depend on the peculiar distribution of land and water in the northern hemisphere? Upon this point Siemens will have to modify his views.

From my analysis we can easily sketch the outline of the general circulation of the atmosphere which corresponds to the present state of the science.

In consequence of the unequal heating of the sun and of the rotation of the earth, air currents occur at all parts of the globe. These currents are easterly between 35° N. and 35° S. latitude, and westerly outside this zone.

In the former zone the easterly currents on the earth's surface (in the northern hemisphere) are more north-easterly and northerly the nearer we approach latitude 35°, while in the higher strata they constantly become more southerly as we approach latitude 35°. This explains the circulation between the equator and latitude 35°. *An upper south-west trade-wind entirely fails in this region.*[2] At or near the equator a calm zone must be formed *at the earth's surface*, where the meridional components of the north-east and south-east trades ascend, but the height of the calm-zone cannot be considerable. Exactly over the calm-zone a pure east wind and the strongest of the whole zone will blow, and the higher the strata under consideration the stronger it will be.

In latitude 35° N. and S., calms exist at the earth's surface. The air, which has an ascending motion in the equatorial calm, has here a descending movement. But above, the current directed polewards continues to exist. Outside this great region, to the north and south, west winds will prevail; while above, the south-west (or the north-west) trade-wind blows, which in higher latitudes will become more and more westerly. At the earth's surface, air in south-westerly or north-westerly motion flows from the zone of high pressure at latitude 35°, which becomes more westerly with increasing latitude. At a mean altitude, however, air flows again from the poles towards latitude 35° as a north-west wind.

This is the picture of the general circulation of the atmosphere according to the latest researches. There is undoubtedly much to be completed, and it presents many dark points which remain to be cleared up, but on the whole it possesses every guarantee of truth and reality, and will doubtless soon be generally accepted. The question of the effect upon cyclones and anticyclones of this general circulation of the atmosphere will certainly come to the front, but we shall have to wait for a considerable time for a satisfactory solution of the problem.

[1] Mr. Abercromby afterwards modified this opinion (NATURE, vol. xxxix. p. 437).—*Translator.*

[2] This statement as to the failure of the upper south-west trade-wind between the equator and lat. 35° was afterwards modified (see *Das Wetter*, 1890, p. 158).—*Translator.*

RELATION OF VOLTAIC ELECTROMOTIVE FORCE TO MOLECULAR VELOCITY.

IN a recent research published in vol. viii., p. 63, of the Proceedings of the Birmingham Philosophical Society, 1892, it is shown, by means of an extensive series of sixty-four tables of measurements of *mean* volta electromotive force, that the *dilution* of the liquid of a voltaic cell by means of water or alcohol, the *liquefaction* of either the positive or negative metal of the cell by means of mercury, the *dilution* of either of these amalgams by means of mercury, or the *dilution* of one solid metal by means of another in an alloy, is universally attended by an increase of *mean* electromotive force of the diluted and diluting substances, and consequently also of the *actual* electromotive force of the diluted one, provided that in all cases no chemical union or other chemical change occurs in the mixture. The manifest explanation of this extensive general result is that, by the act of solution or dilution, the molecules of the active substance are separated farther apart, and consequently acquire increased velocity of motion. In proportion, however, as chemical union occurs, the gain of electromotive force diminishes and is converted into a loss, and the loss is larger in proportion as the chemical union is stronger. The method enables chemical compounds in alloys, amalgams, and electrolytes to be distinguished from mere mechanical mixtures. G. GORE.

SCIENTIFIC SERIALS.

IN the *Botanical Gazette* for February and March, Miss Alice Carter has an interesting paper on evolution in methods of pollination. She points out that the larger proportion of Monocotyledons are either anemophilous or hydrophilous, and this is undoubtedly an earlier method of pollination than the entomophilous. Of the twenty-three natural orders which comprise more than 1000 species, only five are characterized by inconspicuous flowers. Of these, four, viz. the Cyperaceæ, Gramineæ, Urticaceæ, and Piperaceæ, are probably ancestral types, the fifth, Euphorbiaceæ, degenerate. It is probable that the period of the appearance of Dicotyledons was also that of the development of our great groups of insects. The first step towards the attraction of insects was probably the colouring of the stamens, as in *Thalictrum* and *Plantago*; then the development and colouring of the corolla, and the production of saccharine secretions. The most highly developed orders appear to be those in which the number of parts in a floral whorl is small, as the Violaceæ, Compositæ, Labiatæ, and Scrophulariaceæ.—Mr. P. H. Rolfs has an article on the Seed-coats of Malvaceæ; and Mr. Chas. Robertson continues his researches on Flowers and insects.

IN the *Journal of Botany* for March and April, Mr. E. A. L. Batters describes and figures a new marine alga, *Gonimophyllum Buffhami*, the type of a new genus. It belongs to the Delesseriaceæ, an order of Florideæ, and is epiphytic on *Nitophyllum laceratum*, being in fact nearly allied genetically to its host-plant. It was obtained from the coast near Deal.—Mr. R. J. Harvey Gibson describes the hitherto unknown antherids of *Polysiphonia elongella*, the mode of escape and conjugation of the zoogametes of *Enteromorpha compressa*, and the mode of development of the spores of British marine species of *Chantransia*.—Mr. E. G. Baker continues his Synopsis of the genera and species of Malveæ; and Mr. W. H. Clarke his First records of British flowering plants.—The other articles are of interest specially to British botanists.

THE *American Meteorological Journal* for February contains a carefully prepared summary of the proceedings of the International Meteorological Conference at Munich from August 26 to September 2, 1891, by A. L. Rotch. As we have already given a brief account of the Conference, and the report will shortly be published, we need not further refer to Mr. Rotch's article.—The Meteorological station of Naha, Liukiu Islands, Japan, by Y. Wada, of the Tokio Observatory. The station was established in July 1890, and is very favourably situated for the study of the typhoons of the China and Japan seas, as a great many pass near the station. As soon as the island is connected by telegraph with Kiushu it will be the most important of all the Japanese stations for storm-warnings on the coasts of China, Corea, and Siberia.—The wind-rush at Washington, D.C., on November 23, 1891, by Prof. H. A. Hazen. This violent gale was probably the most destructive that has ever been noted at that place. It passed across the city from a south or south-west direction; the wind at the Weather Bureau reached 60 miles per hour [80 miles and upwards have been recorded in this country], but the effects show that during the gusts it must have been very much greater. A cloud-burst occurred during the gale, and the water in a canal which is 25 feet wide rose about 8 feet in a few minutes. The curve showing the barometric oscillation will be found in the *Monthly Weather Review* for that month.

Bulletin of the New York Mathematical Society, vol. i. No. 5 (New York, February).—This number opens with a carefully drawn up account of Klein's modular functions, by F. N. Cole; the occasion being an able presentation of the theory in the work "Felix Klein: Vorlesungen über die Theorie der elliptischen Modulfunctionen, ausgearbeitet und vervollständigt von Dr. R. Fricke." Of this Mr. Cole remarks: "The clearness of treatment and skilful grouping of the many intricate features of the subject have rendered this theory now thoroughly accessible. Dr. Fricke has contributed many of the intermediate steps necessary to the symmetry and completeness of the subject." The reviewer, also a pupil of Klein, supplies many little bits of personal narrative.—The next article is an abstract by "S. N." of the periodic perturbations of the longitudes and radii vectores of the four inner planets of the first order as to the masses, computed under the direction of Simon Newcomb.—Then follows a brief sketch of solution of questions in the theory of probability and averages, by G. B. Zerr. This pamphlet forms Appendix ii. to the "Mathematical Questions . . . from the *Educational Times*."—The notes give a brief account of the Proceedings of the Society, and also contain an addendum to Prof. Hathaway's article (in No. 3), "Early History of the Potential."

Bulletin de l'Académie des Sciences de St. Pétersbourg, nouvelle série, t. ii., No. 2.—A preliminary communication (in German) upon the rocks collected by M. Lopatin on the Podkamennaya Tunguska. The series of Archaic rocks of Siberia, which formerly were described as dolerites, and which so constantly occur in Siberia, offer great difficulties as to their petrographical determination, well known to all geologists. The author now begins the publication of a most welcome monograph on these rocks, based upon no less than 450 samples analyzed under the microscope. The extension of these rocks is immense, as they seem to spread, with small interruptions, in the shape of an immense zone covering the space between 50° and 70° N. lat., over Siberia, North America, South Greenland, Ireland, Scotland, Norway, Sweden, and North Russia. The author describes them as "Palæozoic traps," or typical "plagioclase-pyroxene-olivine rocks," which offer all possible gradations in their evolution. The communication being but a preliminary one, nine different "types" are described and illustrated.—On a new leucite rock from the same locality, by the same author, also illustrated by a plate.—On the Perseids observed in Russia in 1890, by Th. Bredichin (in French). The observations were made by several astronomers at Pulkova, Ostrogojsk, Kineshma, Moscow, and Libau. The weather was not favourable from August 1 to 9, and quite unfavourable on the 12th and 13th. Nevertheless, the author arrives at interesting results in comparing the centres of radiation of the meteors in 1890 with the orbit of the comet 1862 III. The centres of radiation are given on a separate plate.—Combination of the aldehydes with azoic compounds, by J. Bardilowsky (French), being an inquiry into the mechanism of the reaction between the aldehydes and the salts of aromatic amines.—Note on the heat of combination of bromine and iodine with magnesium, by N. Beketoff (French).—On Seldjuk verses, by C. Saleman (in German).—Astronomical determinations in North Russia, by O. Backlund (in German).—Remarks upon the Upper Silurian deposits of the Baltic provinces, in connection with the work of Prof. W. Dames (with a map), by Prof. Fr. Schmidt.

Memoirs of the Kazan Society of Naturalists, vol. xxiii., 1 to 5, and *Proceedings*.—On the tundra of the Kanin peninsula, by A. I. Jacoby, with a map. The author explored the western coast, and gives many interesting facts as to the flora of the tundra and its inhabitants.—On the biology of the *Helianthus annuus*, by A. Gordyaghin. Having discovered that the leaves of the sunflower are visited by nearly twenty different species of insects, and that some of them, especially the ants (*Myrmica lævinodis* and *Lasius niger*), suck the leaves, the author suspected the existence of "extra-nuptial" nectariæ—the supposition being confirmed by a similar observation previously made by Delpino; and he made experiments to ascertain whether drops of nectar do appear on the leaves. The observations have confirmed the supposition; they are being continued.—On the noxious insects of the model farm of the Kazan School, by A. Smirensky.—On the means of measuring the absorbing power of the soil, by B. Sorokin.——The Proceedings contain: a list of 300 birds of the province of Astrachan, by W. Klebnikoff; the report of a Committee nominated for the exploration of the soil in the province of Kazan; a note on the produce of a dry distillation of birch bark; and a report upon ornithological researches in the province of Kazan, with a list of all noticed birds.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, April 5.—W. T. Blanford, F.R.S., in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1892.—Mr. Sclater exhibited and made remarks on the heads of a pair of Swayne's Antelopes (*Bubalis swaynei*) obtained by Mr. J. W. K. Clarke and his party in Somali-land, and sent for exhibition by Messrs. Rowland Ward and Co.—Prof. F. Jeffrey Bell read a note regarding the real habitat of the Land Planarian *Bipalium kewense*, which, as it appeared, was indigenous to one of the South Pacific islands.—A communication was read from Mr. Edgar A. Smith, on the Land Shells of St. Helena, based on a large and complete collection of the terrestrial Mollusks of that island made by Captain W. H. Turton, R.E., and deposited in the British Museum. Mr. Smith estimated the total number of truly indigenous species of this group in St. Helena to be 27, of which 7 only are now living on the island—the remainder having been exterminated by the destruction of the primæval forests.—Mr. F. E. Beddard read some notes on the anatomy of the Indian Darter (*Plotus melanogaster*), as observed in a specimen of this species recently living in the Society's Gardens.—Mr. Seebohm exhibited a specimen of a Pheasant from the valley of Zarafshan in Central Asia, which he referred to a new species, distinguishable from *Ph. principalis* by its white collar, and proposed to call it *Ph. tarnovskii*.—Mr. R. J. L. Guppy exhibited specimens of the animal, the teeth and jaws, and the shell and egg of *Bulimus oblongus*, and remarked briefly thereon.—Mr. G. B. Sowerby read descriptions of seven new species of Land-Shells from the United States of Colombia.—A communication was read from Mr. W. Schaus, containing descriptions of some new species of Lepidoptera Heterocera from Brazil, Mexico, and Peru.

Geological Society, March 23.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On the occurrence of the so-called *Viverra Hastingsiæ* of Hordwell in the French phosphorites, by R. Lydekker.—Note on two Dinosaurian foot-bones from the Wealden, by R. Lydekker.—On the microscopic structure, and residues insoluble in hydrochloric acid, in the Devonian Limestone of South Devon, by Edw. Wethered. Microscopic examination of the Devonian Limestones of South Devon shows that they have been built up by calcareous organisms, but that the outlines of the structure have for the most part become obliterated by molecular changes, and the limestones are often rendered crystalline. In connection with this the author alludes to the disturbances which have affected the limestones. He finds occasional rhombohedra of dolomite, and discusses the probability of their derivation from magnesian silicates contained in the rocks. A description of the insoluble residues follows. The micas, the author considers, may be of detrital origin, but this is by no means certain; he is disposed to consider that the zircons, tourmaline, and ordinary rutile were liberated by the decomposition of crystals in which they were originally included. Minute crystals, referred to as "microlithic needles," resemble "clay-slate needles," but are not always straight: they occur in every fine residue, and as inclusions in siliceous and micaceous flakes. The siliceous fragments which inclose them frequently contain many liquid inclusions, which does not necessarily imply any connection between the two, though there may possibly be some connection. Micro-crystals of quartz occur, and have been derived from decomposing silicates. The reading of this paper was followed by a discussion, in which Dr. Sorby, Prof. Bonney, Dr. Hicks, Prof. Rupert Jones, the President, and others took part.

April 6.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Geology of the gold-bearing rocks of the Southern Transvaal, by Walcot Gibson. The author describes the general characteristics of the rocks of the Southern Transvaal, and gives a summary of previous work on the area; he then discusses the physical relations of the gold-bearing conglomerates and associated rocks in the Witwatersrandt district, and describes the various rocks in detail. He concludes that the gold-bearing conglomerates and the quartzites and shales of the Witwatersrandt district (which have undergone considerable metamorphism) form one series, of which the base and summit are not seen; that this series is much newer than the gneisses and granites on the eroded edges of which they rest, and older than the coal-bearing beds which unconformably overlie them; that the entire series associated with the gold-bearing beds has been thrust over the gneisses, and was not originally deposited in its present position, the movements having taken place in two directions, viz. from south to north and from east to west; that, after the cessation of these movements, the strata were injected with basic and sub-basic igneous material, and much of the country was flooded with lavas of the same character; and that the conglomerates have been formed mainly at the expense of the underlying granites and gneisses, which were largely threaded with auriferous quartz-veins and contained larger masses of quartz. The author then describes the geology of districts outside the typical area, which, though at first sight more complex, are really simpler than that of the typical area. The conclusions arrived at from an examination of these areas confirm the results of the study of the rocks of the Witwatersrandt district. The reading of this paper was followed by a discussion, in which the President, Prof. Green, Mr. Attwood, Mr. Topley, Mr. Alford, Prof. Lapworth, and Mr. Teall took part.—The precipitation and deposition of sea-borne sediment, by R. G. Mackley Browne. The author discusses the mode of deposition of current-borne sediment upon the ocean-floors, and considers the effects of current-action in sifting the material and causing it to accumulate into stratified linear ridges having directions generally parallel with those of the currents—the dip of the strata varying according to the velocity of the currents. He considers that the conclusions deducible from his analysis appear to be in accord with the evidence afforded by the structure of ancient subaqueous sedimentary deposits.

Linnean Society, April 7.—Prof. Stewart, President, in the chair.—Mr. Spencer Moore exhibited and made remarks upon some samples of Maté or Paraguayan tea recently brought by him from South America.—Mr. J. Tristram Valentine exhibited a skin of Grevy's Zebra, recently brought from Somaliland by Mr. H. D. Merewether, who had purchased it from a caravan arriving from the Southern Dolbahanta country, to the south-east of Berbera. Although it corresponded in the character and disposition of the stripes with the type specimen from Shoa, and with a skin in the British Museum from Berbera (P.Z.S., 1890, p. 413), it differed in the stripes being brown upon a pale sandy or rufescent ground, instead of black upon a white ground. It was suggested that this might be the desert form, the type specimen representing the mountain form.—Mr. Tristram Valentine also exhibited horns of Swayne's Hartebeest and Clarke's Antelope (both recently described species), which, like the Zebra skin, had been lately brought from Somali-land by Mr. Merewether.—Mr. W. S. D'Urban exhibited specimens of the shell-slug *Testacella maugei* from Devonshire.—A paper was then read by Mr. D. Morris, on the phenomena concerned in the production of forked and branched palms, the conclusions arrived at being the following:—(1) Branching is habitual in certain species of *Hyphæne*; occasional in others, and occasional also in the genera Areca, Rhopalostylis, Dictyosperma, Oreodoxa, Leopoldinia, Phœnix, &c. (2) Branching in many cases results from injury to or destruction of the terminal bud, causing the development of axillary or adventitious buds below the apex: these buds when lengthened out produce branches. (3) In some cases, as in *Nannorhops ritchieana* and *Phœnix sylvestris*, branching is caused by the replacement of flowering buds by branch buds. In such cases the branches are usually short, and are arranged alternately along the stem. The terminal bud is apparently neither injured nor destroyed.—A paper by Mr. A. W. Waters, on the gland-like bodies in the Bryozoa, was, in the absence of the author, read by Mr. W. Percy Sladen.

Dublin.

Royal Society, March 16.—Prof. W. Noel Hartley, F.R.S., in the chair.—Prof. Haddon presented a paper by Prof. F. Jeffrey Bell on the Echinoderms collected during the Society's fishery survey of the west coast of Ireland. *Psolus*, sp. juv., was recorded for the first time from Ireland (500 fathoms), *Astropecten sphenoplax*, n. sp. (500 fathoms). Amongst other rarities *Asthenosoma hystrix* was largely represented; the specimens differ so much that were it not for intermediate forms, more than one species might be described. Prof. Bell proposes to regard *A.* (*Calveria*) *fenestratum* as a synonym of *A. hystrix*.—G. Johnstone Stoney, F.R.S., read a paper entitled "Proposed Standard Gauge, to help in appreciating the small ultra-visible quantities that have to be taken into account in studying Molecular Physics." The gauge is wedge-shaped. The base of the wedge is formed by taking Ångström's normal map of the solar spectrum, and extending its scale (the degrees of which are millimetres) both ways, till it reaches zero in one direction and 10,000 in the other. The gauge is then completed by erecting a micron or sixthet-metre (sixthet, the fraction represented by one in the sixth place of decimals) over the 10,000 mark and drawing the inclined plane from the top of this to the zero mark at the other end. The gauge is thus a wedge ten metres long, with a gradient of one in 10,000,000, lying upon Ångström's map; and the wave-length of any solar ray is the ordinate (the perpendicular distance from the base-line of the gauge up to its sloping top) immediately over the line representing it in the map. The wave-lengths of *visible* light are the ordinates of this gauge extending from 7·6 to 3·8 metres from its apex. At between 3 and 2 metres from the apex we reach an ordinate which is the *minimum visibile* (the least separation between two points which will admit of their being seen as two with waves so coarse as those of light). The ordinate at one metre from the end is the seventhet-metre (or metre × ·000,000,1). The average distance to which the molecules of air dart in the intervals between their encounters is the ordinate at about three-quarters of a metre from the apex (*Phil. Mag.* for August 1868, p. 138). The ordinate of the gauge at 1 decimetre from its apex is the eighthet-metre (or metre × ·000,000,01). The ordinate at one centimetre from the apex is the ninthet-metre (or metre × ·000,000,001). This is about the average interval at which the molecules of a gas are spaced, when the gas is at the temperature and pressure of ordinary air (*loc. cit.*, p. 140). The ordinate at one millimetre from the apex is the tenthet-metre (or metre × ·000,000,000,1). This is somewhere about the "size" of a gaseous molecule, meaning by this the distance within which the centres of two molecules must come in order that an encounter may take place—that is, that they may be able sensibly to bend each other's path. It may also be taken as about the distance to which the average interval between the centres of the gaseous molecules is reduced when the gas is condensed into a liquid or solid. This is the smallest magnitude for which the gauge is proposed as convenient. Within the last-mentioned small range numerous and complicated events are known to take place, viz. all those that go on within the molecules, among which are those that originate the lines in the spectra of gases. Whenever any way of estimating these quantitatively shall be discovered, we shall want another and more acute-angled gauge to help us in appreciating them.

PARIS.

Academy of Sciences, April 11.—M. d'Abbadie in the chair.—On a new determination of the latitude of Paris Observatory, by M. l'Amiral Mouchez. (See Our Astronomical Column).—Note by M. l'Amiral Mouchez, accompanying a star photograph obtained by Dr. Gill, Director of the Cape Observatory. (See Our Astronomical Column.)—On the flow from rectangular orifices, without lateral contraction: theoretical calculation of the delivery and of its distribution, by M. J. Boussinesq.—On the absorption of light by tourmaline, by M. A. Potier.—Researches on persulphuric acid and its salts, by M. Berthelot.—On the stability of the sand dunes of the Bay of Biscay, by M. Chambrelent. A long account is given of the methods that have been adopted to prevent the encroachment of sand along the coast of the Bay of Biscay.—Note by M. Dehérain, accompanying the presentation of his "Traité de Chimie Agricole."—On a new genus of Cretaceous Echinoids, *Dipneustes aturicus*, Arnaud, by M. G. Cotteau.—Experimental study of the decimal equation in observations of the sun and planets, made at Lyons Observatory, by MM. André and Gonnessiat.—On the latitude obtained by means of the great meridian circle of Paris Observatory, by M. Périgaud.—On a series of determinations of latitude made with the great meridian circle of Paris Observatory, by M. F. Boquet.—Observations of Swift's comet (1892 March 6) and Denning's comet (1892 March 18) made with the great equatorial of Bordeaux Observatory, by MM. G. Rayet and L. Picart.—On the theory of Jupiter's satellites, by M. J. J. Landerer. (For the five preceding communications see Our Astronomical Column.)—On transformations in mechanics, by M. P. Painlevé.—On the evaluation of the numbers of permutations and complete circular arrangements, by M. E. Jablonski.—On the specific heats of metals, by M. Le Verrier. The author has measured the specific heats of lead, zinc, aluminium, silver, and copper, at various temperatures between 0° and 1000° C.—On the polarization of diffused light by disturbed media, by M. A. Hurion.—On the decomposition of silver permanganate and on a particular association of oxygen with silver oxide, by M. Alex. Gorgeu.—On some new salts of iron, by MM. Lachaud and C. Lepierre.—Action of sulphuric acid on some cyclic hydrocarbides, by M. Maquenne.—Researches on some sugar principles, by M. J. Fogh.—On the formation of oxyhæmoglobin by means of hæmatine and albuminoid matter, by MM. H. Bertin-Sans and J. Moitessier.—Law regarding the appearance of the first epiphysiary point of long bones, by M. Alexis Julien.—On an apparatus which enables Paul Bert's experiments on air and compressed oxygen to be easily repeated, by M. G. Philippon.—Distinguishing characters of ovine and caprine species: applications to the study of *Chabins* and Mouflons, by MM. Cornevin and Lesbre.—Halo seen at Parc de Baleine (Allier) on April 6, by M. de Montessus de Ballore.—Research on the geographical and geological conditions which characterize earthquake regions, by M. de Montessus de Ballore.

BERLIN.

Physiological Society, March 18.—Prof du Bois Reymond, President, in the chair.—Dr. Gumlich described experiments made on himself on the urinary excretion of nitrogen. He had determined separately total nitrogen, nitrogen of urea, of ammonia, and of the extractives during periods with a mixed diet, a pure flesh diet, and a vegetable diet. During the second the nitrogen excreted as urea increased until it amounted to 85·6 per cent. of the total nitrogen, and that excreted as extractives and ammonia was also greater than during a mixed diet. During a vegetarian diet the urea nitrogen markedly diminished; that of the extractives and ammonia was also absolutely less than with a meat diet, although it had increased relatively to the rest.—Dr von Noorden communicated, in connection with the above, an extended series of determinations of urinary nitrogen made on patients suffering from different diseases; among these two cases of phosphorus poisoning were of special interest.

April 1.—Prof. du Bois Reymond, President, in the chair.—Dr. Lilienfeld had found that the influence of leucocytes on the clotting of blood is due entirely to their nuclei, the stroma being quite inert. He isolated the chemically active substance from the leucocytes of the thymus gland, and calls it leuconuclein.—Dr. Rosenberg had investigated on a dog working in a tread-mill the assimilation of a diet consisting of definite portions of lean meat, fat, and rice during periods of work and repose, and found it to be the same in both cases. He believes the result of this experiment may be extended to the case of man.—Dr. Schweizer had investigated the behaviour of spermatozoa towards electric currents. Only in a few cases was he able to observe that some of the more active ones swam against the current. He found that the position they assumed in parallel rows with their heads turned towards the kathode was not in any way a result of their vitality.

Physical Society, March 25.—Prof. Kundt, President, in the chair.—Dr. Mewes spoke on emission and absorption.—Dr. Gross, in his experiments, extending over many years, on the decomposition of sulphur has recently tested it electrolyticalty. Barium and strontium sulphate were fused in a silver crucible, which formed one electrode, and a powerful electric current sent through the mass by means of a second electrode of platinum wire. Analyses of the products resulting from the electrolysis yielded a new compound of platinum and barium; at the same time 50 per cent. of the sulphur, originally present as sulphates, was found to have disappeared, and its place to have been taken by 40 per cent. of a new substance, which the speaker had also obtained during the electrolysis of sulphur. According to his views, sulphur is to be regarded as a compound of this new substance with hydrogen.—Dr. Budde described new experiments on the inert layer in emulsions of chloroform and soda, which confirmed him in his view that the layer is due to the rapid evaporation of chloroform from the upper surface of the mixture. A mixture of chloroform and water is even more suitable for the experiments, and, since chloroform is more soluble in cold than in warm water, he takes a solution of chloroform saturated in water at 0°, and then warms it to 20°; at the latter temperature the chloroform separates out in minute drops, yielding a perfectly opaque emulsion, while the upper layer remains clear, owing to the evaporation of the chloroform. When this upper layer is removed by a pipette it remains clear, and must therefore contain less chloroform than the lower saturated portions. The regular configuration of the inert layer in vessels of varying shape had been at one time regarded by Dr. Budde, in agreement with Liebreich, as due to capillary action. His more recent researches have, on the other hand, shown that it is due to currents in the fluid resulting from differences of temperature, and may therefore be altered at will. When the external temperature is lower than that of the fluid, downward currents are established along the walls of the vessel, upward currents in the centre of the fluid, and the meniscus is convex: when the external temperature is higher, the reverse effect is produced, and the meniscus is concave.

April 8.—Prof. du Bois Reymond, President, in the chair.—Dr. Lammer gave an account of alterations made by him, in conjunction with Dr. Brodhan, on a spectrophotometer, with a view to improving the photometric part of the instrument by the introduction of his glass-cube. In connection with the above, Dr. Lammer went very fully into Prof. Abbe's theoretical researches on the delineation of non-luminous objects, which had been made during the latter's studies on the mode of action of microscopes, and transferred the results arrived at by Abbe to the conditions existing in a spectrophotometer.

Meteorological Society, April 5.—Prof. Schwalbe, President, in the chair.—Dr. Sprung spoke on atmospheric rings, and explained the formation of solar and lunar rings as the result of refraction of parallel solar rays in ice-prisms. The prisms must be three-sided, and the maximal intensity of light is obtained when the angle of entry and exit from the prism is 22°, in which case the deviation is minimal. Solar and lunar halos are the result of the bending which light undergoes at the edges of minute ice-particles. The phenomenon can be observed by strewing lycopodium powder on a sheet of glass, and looking at a flame through this film. The speaker further exhibited some photographs of rings and halos, explained the conditions which are necessary for their successful production, and gave the formulæ involved in the calculation of the phenomena.—Dr. Schumbert made a communication in connection with Dr. Lachmann's (see report of previous meeting), and gave a synopsis of temperature maxima and minima observed at woodland stations, both in the woods and just outside them. Some interesting differences were observed, depending upon the kind of trees and the position of the thermometer. After some remarks by Dr. Lachmann on a paper by von Bebber in *Himmel und Erde* on the same subject, Dr. Hofmann in conclusion exhibited an apparatus for registering the observation of meteors.

AMSTERDAM.

Royal Academy of Sciences, April 2.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Kapteyn communicated the result of a discussion of a great part of the photographs taken at the Cape Observatory under the direction of Her Majesty's Astronomer, D. Gill. The diameters of the stars on 370 of these photographs, covering an area of nearly 9000 square degrees of the sky, have been compared to the visual magnitudes of these stars according to the estimations of Messrs. Gould and Schönfeld. It is shown that for stars of equal visual brightness the actinic effect on the plates has been considerably greater for the stars situated in or near the Milky Way, than for stars situated in considerable galactic latitudes. The different causes that may have co-operated to produce this phenomenon have been carefully considered, and the conclusion is arrived at, that neither influences of meteorological causes, nor causes of systematically different sensitivity of the plates, are sufficient to account for it; and that the systematic errors in the estimations of the visual magnitudes are, in all probability, of secondary importance. It seems very probable, therefore, that the principal cause must be sought in peculiarities of the light of the stars themselves. The fact discovered by Mr. Pickering, that the Milky Way must be considered as an aggregation of stars of the first type explains only a small fraction (not 0·1 mag.) of the differences found. Mr. Kapteyn therefore thinks that we are driven to the conclusion that the light of the stars of the first type in the Milky Way is considerably richer in violet rays than the light of stars of the same type in great galactic latitudes. From this would follow, according to the researches of Mr. Pickering, that the same must hold for stars of the other spectral types. In the meanwhile direct photometric and photographic experiments seem very desirable, in order to prove the reality of the phenomenon by more direct evidence than is contained in the plates of the Photographic Survey. Such experiments have been already undertaken by the Cape Observatory.—Mr. Hubrecht gave an account of the placentation of certain Lemurs and Insectivora, as a result of his recent excursion in the Indian Archipelago. The placenta of *Tarsius spectrum* is a discoid one, and differs from that of other Lemuroids hitherto known, in which a diffused distribution of villi over the whole surface of the chorion has been observed. In Nycticebus this coating loses its villous character at one pole of the egg in the latest stages of pregnancy. Certain stages of the discoid placenta of Galeopithecus were further described, as was also the double placenta of *Tupaja javanica*, each placenta having a reniform shape, these being situated right and left of the embryo, which has its ventral surface turned towards the mesometrium.—Mr. Pekelharing reported on his further investigations about the coagulation of the blood. He states that the A. fibrinogen of Wooldridge is the same substance which can be precipitated from the diluted plasma by acetic acid, viz. a nucleo albumin, the zymogen that, by combination with lime, forms fibrin ferment. Wooldridge's tissue-fibrinogen is also a nucleo-albumin from which can be obtained, by treating it with lime-salts, fibrin ferment. In accordance with Dr. Wright, Mr. Pekelharing has found that, in the dog and in the rabbit, an albumose can be split off from the nucleo-albumin, and in this manner the formation of the fibrin ferment can be prevented, or the action of the ferment already formed can be paralyzed.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, APRIL 21

LINNEAN SOCIETY, at 8.—On some New Plants from China: W. B. Hemsley, F.R.S.—On the Relation of the Acaridæ to the Arachnida: H. M. Bernard.

CHEMICAL SOCIETY, at 8.

FRIDAY, APRIL 22.

INSTITUTION OF CIVIL ENGINEERS, at 7.30.—The Speed and Power of Locomotives: Edmund L. Hill.

SATURDAY, APRIL 23.

ROYAL BOTANIC SOCIETY, at 3.45.

MONDAY APRIL 25.

ARISTOTELIAN SOCIETY, at 8.—Prof. Wm. James's Treatment of Self: G. Dawes Hicks.

TUESDAY, APRIL 26

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Social and Religious Ideas of the Chinese, as illustrated in the Ideographic Characters of the Language: Prof. R. K. Douglas.—The Mythology and Psychology of the Ancient Egyptians: Joseph Offord, Jun.

ROYAL STATISTICAL SOCIETY, at 7.45.—An Inquiry into the Statistics of the Production and Consumption of Milk and Milk Products in Great Britain: R. Henry Rew.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Electric-Light Measuring Instruments: James Swinburne.

PHOTOGRAPHIC SOCIETY, at 8.

ROYAL INSTITUTION, at 3.—The Sculpturing of Britain—its Later Stages: Prof. T. G. Bonney, F.R.S.

WEDNESDAY, APRIL 27.

GEOLOGICAL SOCIETY, at 8.—Notes on the Geology of the Northern Etbai or Eastern Desert of Egypt; with an Account of the Emerald Mines: Ernest A. Floyer.—The Rise and Fall of Lake Tanganyika: Alex. Carson. (Communicated by R. Kidston.)

ENTOMOLOGICAL SOCIETY, at 7.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, APRIL 28.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on the Light of the Electric Arc: A. P. Trotter.

ROYAL INSTITUTION, at 3.—The Chemistry of Gases: Prof. Dewar, F.R.S.

FRIDAY, APRIL 29.

INSTITUTION OF CIVIL ENGINEERS, at 7.30.—The Steam-Hammer and its Relation to the Hydraulic Forging-Press: H. H. Vaughan.

ROYAL INSTITUTION, at 9.—The Physiology of Dreams: Dr. B. W. Richardson, F.R.S.

SATURDAY, APRIL 30.

ROYAL INSTITUTION, at 3.—J. S. Bach's Chamber Music (with many Musical Illustrations): E. Dannreuther.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Blowpipe Analysis, 2nd edition: J. Landauer; translated by J. Taylor (Macmillan).—Air Comprimé ou Raréfié: A. Gouilly (Paris, Gauthier-Villars).—La Distribution de l'Electricité, Installations Isolées: R. V. Picou (Paris, Gauthier-Villars).—Résistance des Matériaux: M. Duquesney (Paris, Gauthier-Villars).—Machine à Vapeur: V. Dwelschauvers-Dery (Paris, Gauthier-Villars).—Elements of Materia Medica and Therapeutics: C. E. A. Semple (Longmans).—Fruit Culture: J. Cheal (Bell).—My Water-cure: S. Kneipp (Grevel).—Color-vision: E. Hunt (Simpkin).

PAMPHLET.—On the Physics of Media: J. J. Waterston (Kegan Paul).

SERIALS.—The Asclepiad, No. 33, vol. ix. (Longmans).—Geological Magazine, April (K. Paul). Journal of the Royal Agricultural Society, 3rd series, vol. iii. Part 1 (Murray).—Himmel und Erde, April (Berlin, Paetel).—The Annals of Scottish Natural History, No. 2 (Edinburgh, Douglas).—Journal of the Institution of Electrical Engineers, No. 96, vol. xxi. (Spon).—The Eagle, March (Cambridge, Johnson).—Journal of Anatomy and Physiology, vol. xxvi. Part 3 (Williams and Norgate).—Mind, April (Williams and Norgate).—Massachusetts Institute of Technology, Boston, Annual Catalogue, 1891–92 (Boston).—Journal of the Royal Statistical Society, March (Stanford).—Journal of the Chemical Society, April (Gurney and Jackson).—Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, nouvelle série, ii., xxxiv., feuilles 34–41.—The Engineering Magazine, April (New York).

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