THURSDAY, OCTOBER 25, 1894.

TWO TEXT-BOOKS OF BOTANY.

A Students' Text-book of Botany. By Prof. S. H. Vines, M.A., D.Sc., F.R.S. (First half.) With 279 Illustrations. (London: Swan Sonnenschein and Co., 1894.)

The Students' Introductory Handbook of Systematic Botany. By Joseph W. Oliver. (London: Blackie and Son, 1894.)

WE are very glad indeed to welcome Prof. Vines' new book. It is the first English text-book of modern botany that has yet appeared. The book has grown out of the author's translation of Prantl's "Lehrbuch der Botanik," but, as Prof. Vines tells us in the preface, "though the form of Prof. Prantl's book is retained, and here and there paragraphs from the English edition have been inserted, it is essentially a new book, for which he alone is responsible."

The difficulties in the way of writing a good comprehensive text-book of botany are very great. Owing to the huge amount of material, much of it mere detail, which accumulates day by day, the work of selection becomes increasingly laborious to any writer who is anxious to produce a text-book which shall be of real value to the advanced student. Perhaps no botanist was so well fitted to undertake this work as Prof. Vines, and he has done the work carefully and well. Modern researches have been incorporated wherever possible, and the author has placed his facts before the reader in a very clear, but somewhat encyclopædic manner. We must protest against the terminology. The author has introduced a large number of new terms, many of which seem to be quite superfluous, and likely to render the study of botany unnecessarily confusing to the student. Added to this, the book is, unfortunately, not got up in a very attractive style; the illustrations are poor, and the majority of them will be familiar to the student of botany. They have appeared over and over again in all sorts of text-books, good and bad, and it is much to be regretted that an adherence to these old figures should have become traditional.

The volume before us is only the first half of the book. It is divided into three parts, which deal respectively with morphology, the intimate structure of plants (anatomy and histology), and the classification of plants; the latter includes the Thallophyta, Bryophyta, and Pteridophyta, the description of the Phanerogams being reserved for the second half of the book.

Part i. is divided into two chapters and an introduction. In the latter some fundamental points are considered, the meaning of the terms morphology and homology explained, and a general description given of polymorphism, or alternation of generations, as exemplified in the moss, which is taken as occupying a central position, of morphological equality in the two generations, in the vegetable kingdom.

The development of the body and its members is treated excellently. Holoblastic and meroblastic development are explained. The difference between homoblastic and heteroblastic embryology is discussed. The latter kind of development is seen most strongly marked in the Characeæ, Mosses, Lemanea, and Batrachospermum, where two distinct stages in the development of the gametophyte can be observed.

In chapter ii. the special morphology of the members, thallus, stem, leaf, root, &c., is treated in detail. The description given of the leaf is excellent. The form of the leaf and its various parts are first of all described, then the development of the leaf, its branching, heterophylly, bud scales, &c. The leaf is regarded, from Bower's point of view, as a branch system. In most plants the leaf undergoes differentiation or segmentation along its longitudinal axis or phyllopodium. The result is that we get in the most complete cases the phyllopodium differentiated into leaf base or hypopodium, mesopodium or petiole, and an apical part or epipodium. The epipodium is typically winged and forms the lamina, the mesopodium is rarely winged, the hypopodium more frequently so, forming the stipules or leaf-sheath. The branching of the leaf is commonly confined to the epipodium, and is like that of a stem or root, either dichotomous or lateral, but dichotomous branching is rare. The ribs of the lamina represent distinct axes of growth. In some cases the growth of these axes and their respective wings results in the production of leaves with an entire margin; in other cases the growth is more irregular, and lobed, or segmented leaves are produced.

The morphology of the reproductive organs is next considered, the vegetative, asexual, and sexual modes of reproduction being described in some detail. Bracts and perianth leaves are included under the common term hypsophylls. In connection with spore formation we think Prof. Vines has introduced an unnecessary distinction between spores which are produced on the gametophyte and spores which are produced on the sporophyte, especially as, in the cases where this is said to occur, the distinction between gametophyte and sporophyte is, to say the least, not well marked. When the spores are produced on a gametophyte they are called gonidia, the sporangia are called gonidangia, and he sporophores are called gonidiophores.

Part ii. deals with the intimate structure of plants, and is divided into two chapters, on the cell and the tissues respectively. The relation of multinucleated cells to uninucleate is explained. The multinucleate segment is regarded as a collection of protoplasmic units, *energids* (a term due to Sachs), and is termed a cœnocyte. But, as the author points out, true multinucleate cells are produced in some plants by fragmentation of the original nucleus, as in the internodal cells of Chara.

In connection with the minute structure of the cell, and the division of the nucleus, we find that many of the more important recent researches are included.

The important observations of Guignard on centrospheres are shortly described, and one or two of his figures are given in illustration. Here again the author's statement that "closely associated with the nucleus is a body called the centrosphere," appears to us to be too general, as centrospheres have not yet been discovered in all the groups of plants, although the observations which have been already made, lead one to the conclusion that they will ultimately be discovered in connection with all nuclei.

In chapter ii., under the heading of Tissues, the author describes the connection of the cells, intercellular spaces, the various forms of tissue, including "sieve tissue," glandular tissue, parenchymatous, strengthening, and tracheal tissue. The general morphology of the tissue system deals with the apical growth of plants, and the morphology of the stele. The researches of Van Tieghem are here included. The variations from the primitive monostelic structure of the stem are polystelic and schizostelic. The latter term, which corresponds to Van Tieghem's old term "astelic," is, in our opinion, a great improvement.

The fundamental tissue system or ground tissue is divided into extra-stelar and intra-stelar. In monostelic stems the limits of the extra-stelar tissue are the endodermis and the layer of cells immediately below the epidermis. In polystelic stems the extra-stelar tissue includes all the fundamental tissue outside the steles. The intra-stelar or conjunctive tissue includes the pericycle and pith.

A very good description is given of the secondary extra-stelar tissue. In the description of cork formation, the classification of Van Tieghem is adopted as regards the place of origin of the phellogen. We should like to have seen in this section some account of the conditions which, probably, determine the formation of special kinds of periderm. The chapter concludes with a short account of the formation of tissue in consequence of injury.

In the third part the classification of the vegetable kingdom into four groups, Thallophyta, Bryophyta, Pteridophyta, and Phanerogamia, is described. While recognising the general usefulness of such a division, we think it would have been better to separate the Bacteria and Cyanophyceæ to form another group—which has already been done by some writers—the Protophyta. The characteristics of the Bacteria are peculiar to themselves, and are such as to warrant their separation from the Fungi; and the same may be said of the Cyanophyceæ, and their connection with the Algæ.

The author adheres to the classification of the Algæ into four sub-classes: Cyanophyceæ, Chlorophyceæ, Phæophyceæ, and Rhodophyceæ. An excellent introductory account is given of the whole class, followed by a special description of each sub-class and its principal orders and families. The Chlorophyceæ is divided into five series: Protococcoideæ, Volvocoideæ, Siphonoideæ, Confervoideæ, and Charoideæ, a classification with which we cordially agree. It has been customary to place the Charoideæ between the Algæ and Bryophyta as a separate group, but we think their inclusion as a sub-group of the green Algæ is, in spite of the differences which exist between them, more in accordance with their structure.

A short but excellent description is given of the Phæophyceæ. The author includes the unicellular forms, Syngeneticæ and Diatomaceæ, in this group. This may be convenient, but few botanists will, we think, regard it as natural. A short general account of the red seaweeds, with a list of the orders and chief genera, concludes this portion of the book.

The next group dealt with is that of the Fungi. A general account is first of all given of the structure and methods of reproduction. The asexual formation of spores is of general occurrence. In accordance with the author's terminology, these are distinguished as gonida and spores, according as they are borne on the gametophyte or sporophyte. The ordinary mycelium of mucor, for example, is the gametophyte; on this are produced gonidangia and gonidia. On the other hand, the zygospores of some mucors produce a promycelium; this is regarded as the sporophyte, and its asexual reproductive organs are therefore sporangia and spores. Again in the Peronosporaceæ, "in those species in which the oospore gives rise to a promycelium, the promycelium is the sporophyte; in those in which the oospore gives rise to zoospores, the oospore itself represents the sporophyte, and finally, in those in which the oospore at once gives rise to a sexual plant, the sporophyte is altogether unrepresented." The ordinary mycelium is here also the gametophyte.

The book concludes with an account of the vascular Cryptogams. The classification adopted by the author is more in accordance with the known facts of morphology, and is a distinct advance in the right direction. One of the most striking changes is the complete separation of the Isoëtaceæ from the Selaginellaceæ, and its inclusion among the Eusporangiate Filicineæ. A useful table is given on p. 380, showing the relations of the various groups of the Pteridophyta.

In connection with the Lycopodiaceæ, Treub's important observations on the embryogeny of the sporophyte and the structure and development of the gametophyte are incorporated. This is the first time these important researches have been described in an English text-book.

In conclusion, English students have cause to be grateful to Prof. Vines for this excellent text-book, which puts before them so clearly and definitely the main facts and conclusions connected with the science of botany; and we look forward with great interest to the appearance of the second half of the book, which has been promised for the current year.

The second book before us is, the author tells us in his preface, designed for the use of students who have passed through an elementary course of botany. It is a compilation from several English works and Le Maout et Decaisne's "Traité Général de Botanique," and the author has been at some pains to select from them such portions as will be most useful to beginners. In this he has been fairly successful, and has placed his facts before the reader in a commendably simple form.

The author is not without hope that the book may be used for private study, but we could not recommend it for this purpose. It would be perfectly useless to place such a book in the hands of a private student, unless he were better acquainted with the elements of botany than the majority of students in elementary classes.

A little more than one-third of the book deals with Cryptogams, the remainder of the volume being devoted to a description of the structure and classification of the Phanerogams. We can heartily commend the author's lucid description of some of the types he selects to illustrate the various groups. On the other hand, many of the types are described by him in such a way as to give the student very little idea of the plant he is supposed to be studying.

The second part of the work deals with the Phanerogams. A very fair account is given both of the Gymnosperms and the Angiosperms. The major portion of this part of the book, however, is taken up with a description of the natural orders of the Angiosperms.

Though there are a few new illustrations in the book, the majority of them are the old familiar ones referred to in the foregoing. We notice that the author has sometimes forgotten to acknowledge the source from which his illustrations have been taken.

In conclusion, it may be said that the book is very well suited to those students who wish to pass a somewhat advanced examination, such as that of the Science and Art Department. We cannot help regretting, however, that there should be so large a demand for this kind of text-book. HAROLD WAGER.

LIFE IN ANCIENT EGYPT.

Life in Ancient Egypt. Described by A. Erman; translated by H. M. Tirard. (London: Macmillan and Co., 1894.)

THE appearance of an English translation of Prof. Erman's work on the manners and customs of the ancient Egyptians is most opportune, for it comes at a time when the Egyptological world is still smarting under the loss, by death, of Prof. H. Brugsch, the last and probably the greatest of the little band of German Egyptologists of which Lepsius was such a brilliant member, and proves to us that there is in Germany, besides Dr. Wiedemann, one at least who may be expected to continue the great and good work which that veteran did so much to promote. Prof. Erman is well known to Egyptologists by his papers and books on Egyptian grammar, of which from the time of his appearance at the Congress of Orientalists in 1874 until the present year he has never ceased to labour. In 1878 he published some important observations on the formation of the plural in Egyptian ("Die Pluralbildung des Aegyptischen," Leipzig, 1878), which was followed in 1880 by his "Neuaegyptische Grammatik"; in 1890 he edited, with translation, commentary, &c., the stories from the Westcar papyrus ("Mittheilungen ans den orientalischen Sammlungen—Die Märchen des Papyrus Westcar"), and last year he published a good little Egyptian grammar. A portion of his time he has devoted to contributing articles to the *Aegyptische Zeitschrift*, of which he is now the editor, and to the *Zeitschrift* of the German Oriental Society. His work on the life of the Egyptians, which in an English form we owe to Mrs Tirard, appeared in parts, which formed two volumes, between the years 1884 and 1887, and was then, and is now the only work of the sort in Germany. The large work by Ebers, "Aegypten in Bild und Wort," which appeared at Stuttgart in 1879–81, and of which an English translation by Clara Bell was published in London in 1881–82, attracted the popular mind chiefly by the many beautiful illustrations which it contained; references to original authorities were few and far between, but it nevertheless appealed to a large class of readers successfully. Our own countryman, Wilkinson, the author of the first guide-book to Egypt, was perhaps the first to recognise that the only trustworthy descriptions of the manners and customs of the Egyptians must be derived from the native records of sculptor, artist and scribe, and he spent many years in compiling his monumental work on the subject, which, as Mrs. Tirard says in her preface, has formed one of the main sources of supply for Prof. Erman. Wilkinson's knowledge of the inscriptions was somewhat hazy according to modern views, and the defects which occur in his work from this cause are conspicuous by their absence in Prof. Erman's book, which is of course, as was to be expected, a record of the Egyptians compiled from their own monuments and books. On many points we should like to have had his opinions, as for example, on the Hyksos, and on the Exodus; as for the Hittites, on which nation more than one reputation has been wrecked, he holds no strong view, but thinks they may have been identical with the Kheta of the hieroglyphics. In matters of chronology Prof. Erman differs greatly from Mariette and Maspero, for he places the sixth dynasty as late as B.C. 2500, while they date it at B.C. 3700 and 3300 respectively. There is no doubt that serious modifications in Egyptian chronology must shortly be made, and though they may take the form of reducing the antiquity of the periods of the dynasties from the twelfth downwards, yet it seems perfectly clear that the effect of the rearrangement ought to be either to lengthen the period of the duration of the earlier dynasties, or to admit boldly a more recent date for the beginning of historical Egyptian civilisation, and to proclaim a lengthy period of prehistoric civilisation which in all probability extended over thousands of years. Such considerations, however, affect Prof. Erman's book very little, for the reader will rely upon him not for speculations as to the original home of the Egyptians and the history of their descendants who are known to us, but for the descriptions of their life as depicted on their works; in this respect no more careful guide than Prof. Erman could be found. The tasteful form in which his book is printed and bound will, we believe, add to its intellectual attraction.

OUR BOOK SHELF.

La Géographie littorale. Par Jules Girard, Secrétaire-adjoint de la Société de Géographie (Paris). (Paris: Société d'Editions Scientifiques, 1895 [1894].)

M. GIRARD says very justly in his preface that geographers have not as yet given the coast-lines of the world the attention to which these features are entitled. He accordingly prepared the present little book, which has appeared, chapter by chapter, in the *Revue de Géographie.* It is unquestionably a useful compilation, but it is far from complete in any part; and it has been so carelessly revised, that a number of printer's errors remain unnoticed. In the names of places outside France the letters *u* and *n* are frequently transposed. Bab-el-mandeb appears as *Bal-el-Mandel*, and an extraneous *r* creeps into several names beginning with G, *e.g. Granges* for Ganges, and *Gruppy* or *Grupy* for Guppy. More serious are blunders in statements of facts, such as describing the whirlpool of Corryvrechan as being near the island of "Scabra," *dans les lacs d'Écosse*, the transference of the Grey Man Path from the north of Ireland to the west of Scotland, and the description of the Old Man of Hoy as the result of erosion in schistose rock, whereas it is a mass of horizontally stratified Old Red Sandstone. These examples might be considerably reinforced were detailed criticism necessary, but a graver defect is the way in which work done by others than Frenchmen has been ignored. Reference is certainly made to several British, German, Russian, and American writers, but rarely at first hand, and many works of the first importance have been entirely overlooked.

There are seven chapters dealing successively with the movements of water in the sea, coast erosion, the movements of sand (the two most satisfactory chapters), the origin of beaches, deltas, estuaries, and the evidence of movements of the land along the coasts, including the origin of fjords.

The treatment of estuaries is particularly inadequate. The Amazon and Congo are scarcely seriously touched on, the part of salinity in determining the *régime* of tides in an estuary is practically overlooked, and the relation of the volume and velocity of a river to the volume of its estuary is not worked out at all. Perhaps the most marked omission is Prof. Osborne Reynolds' magnificent experiments on the synthesis of sandbanks by tides, and the controlling relation of the configuration of the coasts to that of the banks.

But with many faults of execution, the plan of the book is sound, and the work supplies a framework for a treatise of great value, which might be furnished if the author would first prepare a bibliography of the subject, and then undertake a thorough and leisurely revision. H. R. M.

The Mechanics of Hoisting Machinery. By Dr. Julius Weisbach and Prof. Gustav Herrmann. Translated from the second German edition by Karl P. Dahlstrom, M.E. (London and New York: Macmillan and Co., 1893.)

THIS book is a translation from Prof. Herrmann's revised edition of Weisbach's great work on engineering mechanics. Several volumes of this work are familiar to English readers. The present section, however, has not previously appeared in English print, although its value has long been recognised. Mr. Dahlstrom was induced to undertake the translation, because he felt that there was a want in our technical literature for a text-book suitable for the higher grades of mechanics of machinery.

As the title implies, the contents of the work are entirely concerned with hoisting machinery; commencing with the simple lever and screw-jacks, and going on with all kinds of pulleys and blocks, windlasses and lifts, as well as hydraulic plant, concluding with hoisting machinery for mines, cranes and sheers, excavators, and dredgers, &c.

The treatment of these subjects is such that criticism is nearly unnecessary. The examples and illustrations are nearly all taken from every-day engineering practice; some are, however, old-fashioned. Senior students will obtain many useful hints in this book, more especially on studying the methods of working out the examples throughout the volume. The diagrams are very clear and to the point. One cannot help noticing that the illustrations have in many cases a decidedly foreign appearance, and the design would not be followed in this country; nevertheless, they serve the very useful purpose of illustrating theoretical constructions by means of every-day objects. Fig. 65 represents the usual woodcut of the essential arrangement of an hydrostatic press. The ram of the force-pump is shown the full diameter of the cylinder, and therefore no passage exists for the water to pass from the suction to the delivery valve on the down stroke. Fig. 105 represents a two-cylinder geared steam winch, fitted with a peculiar slide valve. A description of this valve would have been interesting, because only one eccentric appears to be necessary, thus doing away with the noisy link motion, especially when badly worn.

The many references given add considerably to the value and usefulness of this work, while the able mathematical treatment of the more difficult examples leaves nothing to be desired. The translator may be congratulated on having added one more useful book to the library available to the student and engineer.

N. J. L.

An Elementary Manual of Zoology. By E. C. Cotes. Pp. 119. (Calcutta: Government Printing Office, 1893.)

THE encouragement given to scientific instruction and research by the Indian Government is known to all who see the many interesting and important publications which issue from the different departments. Most branches of natural knowledge are fostered in India with a care which could be followed with advantage in the British Isles. The work before us is not a voluminous report, nor is it a richly illustrated monograph of the kind that often emanates from the various departments of the Government. In its way, however, it will do excellent service by providing a course of zoology suitable for the use of students at the Imperial Forest School, Dehra Dun. The author, who is lecturer on zoology in that school, and deputy superintendent of the Indian Museum, points out that the particular animals with which the Indian Forest officer is concerned are not treated in sufficient detail in the general text-books. His manual admirably supplies the requisite information, and furnishes a sound elementary course on the classification and habits of the commoner Indian animals. The work is divided into two parts, the first of which is a systematic course, while the second consists of directions for the dissection and examination of specimens. Theory and practice are thus each given a proper share of consideration. The book is a practical one, and the theoretical matter included in it is only such as is likely to be of use to the students for whom it has been designed. Little reference is therefore made to the fundamental theories of modern biology.

Preservation of Health in India. By Sir J. Fayrer, K.C.S.I., F.R.S. Pp. 51. (London: Macmillan and Co., 1894.)

THE young European who is about to take up a long residence in India, could not do better than "read, mark, learn, and inwardly digest" what Sir Joseph Fayrer has to say about the preservation of health there. In this primer, so small that it will almost fit into the waistcoat-pocket, we find a good summary of information with regard to the physical characters and the climate of India. To obviate the deleterious action of the latter, and preserve health, the author lays down a few simple hygienic rules which must be observed. He describes the diseases and accidents in which immediate aid is required, and states briefly the antidotes to be employed in each case. Readers of the book will acquire, pleasantly and easily, a fund of useful knowledge on the most important points concerning health and possible sickness in our Eastern Empire.

First Principles of Building. By Alex. Black. Pp. 329. (London: Biggs and Co.)

THEY who build houses will find many matters connected with their occupation, presented in a practical light, in the book under review. The choice and preparation of a site, the planning of the dwelling, and the nature and use of the materials to be employed, are considered by the author from a technical point of view. The work is a practical handbook for architects and builders, and contains a mass of highly-compressed information on all points pertaining to the erection of residences.

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.*]

The Inheritance of Acquired Characters.

IT may be of interest to your readers to know that two guinea-pigs were born at Oxford a day or two before the death of Dr. Romanes, both of which exhibited a well-marked droop of the left upper eyelid. These guinea-pigs were the offspring of a male and a female guinea-pig, in both of which I had produced for Dr. Romanes, some months earlier, a droop of the left upper eyelid by division of the left cervical sympathetic nerve.

This result is a corroboration of one series of Brown-Séquard's experiments on the inheritance of acquired characteristics. A very large series of such experiments are of course needed to eliminate all sources of error, but this I unfortunately cannot carry out at present, owing to the need of a special farm in the country for the proper care and breeding of the animals. LEONARD HILL.

Physiological Laboratory, University College, London, October 18.

"Rhynchodemus Terrestris" in Ireland.

IT is now nearly twenty-five years ago since Sir John Lubbock discovered this Land-planarian for the first time in England. Although it is very doubtful whether the two other species, viz. *Geodesmus bilineatus* and *Bipalium kurense*, can be looked upon as truly indigenous in Europe, it is not so with *Rhynchodemus terrestris*.

Since Müller's original discovery of this worm in 1774 in Denmark, it has been taken in the Balearic Isles, near Lille, and on the Mediterranean coast in France, and near Würzburg in Germany. Finally, Sir John Lubbock speaks of it as having been found in Shropshire and Kent in England. More recently Mr. Harmer discovered it near Cambridge, and I have now to add a new locality, having received some specimens from Blackrock, near Dublin. R. T. SCHARFF.

October 22.

Dr. Watson's Proof of Boltzmann's Theorem on Permanence of Distributions.

IN working over Dr. Watson's proof of Boltzmann's H-theorem (Watson, "Kinetic Theory of Gases," second edition, p. 43), it appeared that, probably through a slip, the reasoning given depends on an assumption palpably absurd, *i.e.* that the function whose vanishing defines the beginning or end of an encounter between a molecule belonging to a set with m degrees of freedom and one belonging to another set with n degrees of freedom *is a function of the coordinates of the last molecule only*, the one belonging to the n set. For while he takes the number of molecules of the n set whose momenta and coordinates lie between

$$p_1 \text{ and } p_1 + dp_1 \;\ldots\ldots\; q_n \text{ and } q_n + dq_n$$

as

$$f(p_1 \;\ldots\ldots\; q_n)\, dp_1 \;\ldots\ldots\; dq_n,$$

he also takes $q_n = 0$ as the condition of encounters between those molecules and others from a set whose coordinates are

$$P_1 \;\ldots\ldots\; Q_m.$$

I do not know Boltzmann's proof, but while I suppose it is all right, I find it very hard to understand how any proof can exist. *A priori* the only physical property assumed in Watson's proof is that

$$dp_1 \;\ldots\ldots\; dq_n = dp_1' \;\ldots\ldots\; dq_n',$$

together with the fact that the number of molecules about a configuration $p_1 \;\ldots\ldots\; q_n$ is

$$f(p_1 \;\ldots\ldots\; q_n)\, dp_1 \;\ldots\ldots\; dq_n;$$

and therefore it would, if true, apply to a system obtained by reversing the velocities when the permanent configuration had been very nearly reached. Such a system would retrace its path and go further and further from the permanent configuration.

Hence it would appear as if the whole conception of Dr. Watson's proof was founded on a mistaken idea of what can be proved, and that all that any proof could show is that, taking all the values of $\frac{dH}{dt}$ got from taking all the configurations which approach towards a permanent configuration of the molecules, *and* the configurations which recede from the permanent configuration (obtained by reversing velocities), and then striking some kind of average among them, the average $\frac{dH}{dt}$ would be negative.

Will some one say exactly what the H-theorem proves?

EDWD. P. CULVERWELL.

Trinity College, Dublin, October 12.

The Meteor-Streak of August 26, 1894.

SINCE the publication of my paper in NATURE of September 27, in which I discussed observations of the fireball of August 26 and its drifting-streak, I have received many additional descriptions which show that some of the earlier reports were not very accurate. The results I derived for the direction and rate of motion of the streak have therefore to be considerably amended to agree with the new materials.

From all the data I find that the height of the streak was fifty-four miles above a point seven miles north-east of Denbigh. From thence it travelled horizontally to south-east, passing successively over Ruabon, Denbighshire, and Wem and Wellington, Shropshire, finally becoming extinct six miles west of Wolverhampton, at just about the same height as at first. It traversed sixty-one miles in thirty minutes, which is equivalent to 176 feet per second.

This deduction differs from the previous one, which assumed the meteoric or cosmic cloud to have been rapidly ascending in the atmosphere during the time it remained visible. Mr. Wood, of Birmingham, obtained a similar result from the earlier observations. I feel certain, however, that no such upward movement of the cloud really occurred, but that it maintained, throughout its rapid drift to the south-east, a nearly uniform elevation of about fifty-four miles above the earth's surface.

Bristol, October 14. W. F. DENNING.

Flight of Oceanic Birds.

JUDGING from Mr. Kingsmill's photograph, it would appear that the bird is just in the position of the half-stroke of the wings when making a fresh start or a sudden spurt. While these birds generally sail about, yet at times they do flap their wings. The movement of the wings in all these oceanic birds is very deliberate. I might here be allowed to point out the interest attaching to such photographs as these; and as many have hand-cameras now, snap-shots of animal life at sea, or of any natural phenomena, would be valuable and interesting additions to our knowledge of sea life. D. WILSON BARKER.

Greenhithe, October 13.

A LONG-PERIOD METEOROGRAPH.

IN order to obtain a record of the principal meteorological variations at the summit of Mont Blanc, M. Jules Richard, of the well-known firm of scientific instrument makers, has constructed for Dr. Janssen a meteorograph which will run through the winter and spring without being re-wound.

The instrument (Fig. 1) is set in action by a weight of about ninety kilograms, which falls from five to six metres in eight months. This weight moves a pendulum, which regulates the movement of the various parts of the apparatus. It was essential that the motion of the pendulum should not be greatly affected by considerable variations of temperature. A modified form of Denison's escapement was therefore adopted by M. Richard (Fig. 1, A.). An advantage of this escapement is that it only requires a very minute quantity of oil. Denison was unable to detect any variation in the uniform motion of the pendulum when the oil had frozen to the consistency of tallow.

All the movements of the meteorograph are given to the respective instruments through a horizontal shafts

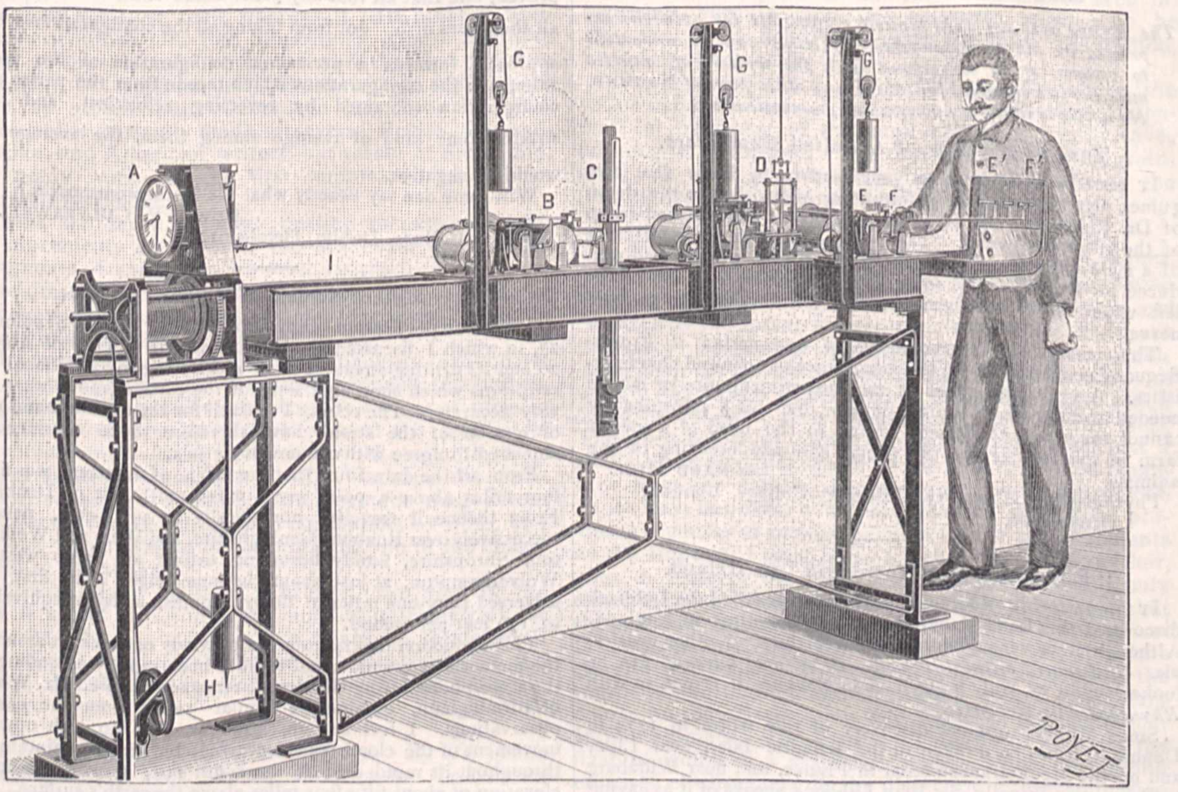

FIG. 1.—Long-period meteorograph for the Mont Blanc Observatory. A, clock to run eight months; B, barometric recording system: C, mercury barometer; D, registering anemometer and anemoscope; E, pen of thermometer; F, pen of hygrometer; E', reservoir of thermometer; F', hairs of hygrometer; G, G, G, counterpoises for ensuring the regular movement of the paper spindles; H, pendulum of clock; I, transmitter of the clock-movement to the different recording systems.

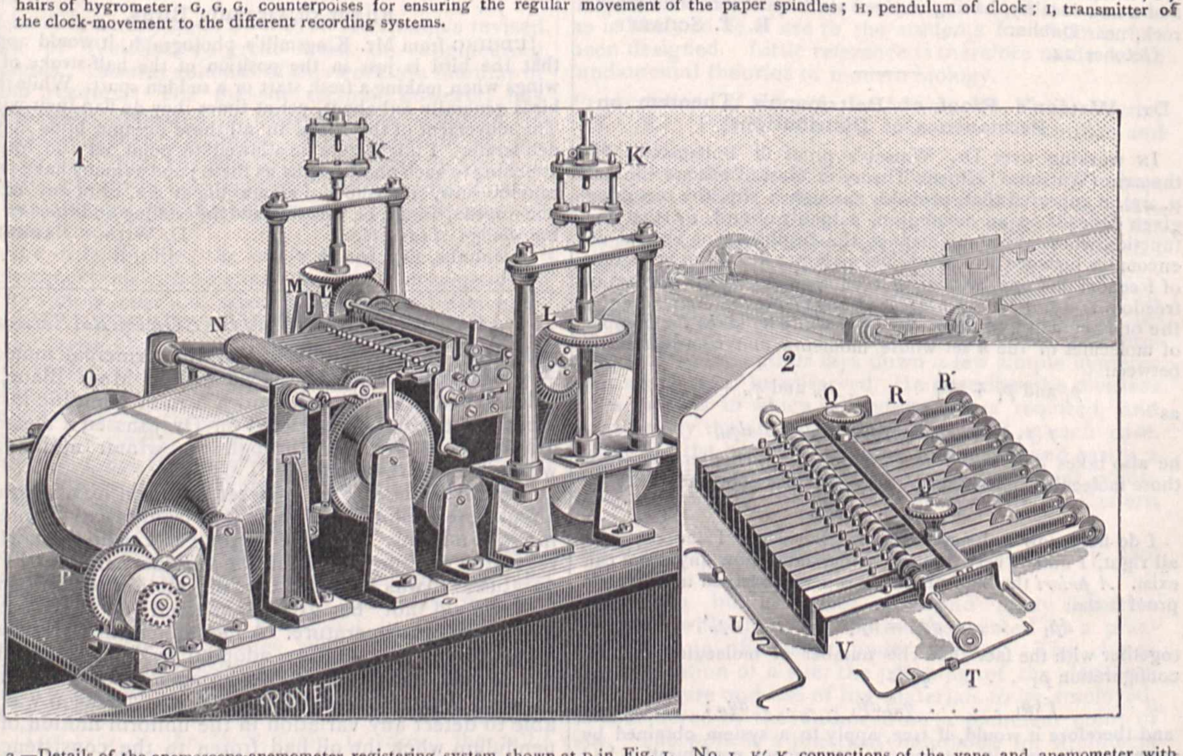

FIG. 2.—Details of the anemoscope-anemometer registering system shown at D in Fig. 1. No. 1. K', K, connections of the vane and anemometer with the registering system; L, cog-wheel for velocity of wind (anemometer); L', cog-wheel for direction of wind (anemoscope); M, group of recording pens; N, roll of paper; O, magazine for paper upon which records have been traced; P, system actuated by the counterpoise G, and serving to roll up the used paper. No. 2. General view of the writing system. Q, Q', buttons for lifting the pens; R, R', rollers actuated by the cog-wheels L and L'; T, detail of the pen-tube of the anemoscope; U, detail of the pen-tube of the anemometer; V, series of pen-tubes.

which is in connection with the pendulum. The shaft is completely rotated round its axis once in twenty-four hours, and this diurnal motion is communicated to the bobbins of paper belonging to the different registering instruments. The paper on these bobbins is unrolled with a different velocity for each instrument.

The instrument for registering variations of atmospheric pressure is shown at B, in Fig. 1. The marking needle records the movements of the mercury in the lower branch of a Gay-Lussac barometer having a very large cistern.

For recording variations of temperature, metallic reservoirs on the Bourdon system are employed, and for humidity a hair or Saussure's hygrometer is used. The velocity and direction of the wind are registered by a new arrangement devised by M. Richard, the principle being as follows:—A cylinder, carrying a certain number of cogs, arranged helically on its surface, is connected with a Robinson's anemometer, and acts by means of the cogs on an equal number of pens, each of which is lifted up in succession and made to mark the drum of paper so long as the cog acts upon it. For registering direction, the apparatus is provided with eight separate pens for the eight principal directions of the wind. For velocity, the cylinder carries ten cogs, which act successively on ten pens. Each pen is geared during one-tenth of a complete rotation of the cylinder, and, knowing the rate of movement of the cylinder, the velocity of the wind may be found from the length of the traces made by the different pens.

The descriptions beneath the accompanying illustrations, for which we are indebted to *La Nature*, tell the use of the different parts of the instrument. In spite of the many precautions which have been taken, Dr. Janssen recognises that the instrument is more or less tentative in character. But the question of long-period meteorographs for meterological stations at high altitudes is so important that the result of the experiment will be awaited with great interest.

NORTH AMERICAN MOTHS.[1]

MANY works on North American butterflies, and on some groups of moths also, have been published of late years, but the important family of the Noctuidæ has hitherto been much neglected. A great deal has been done in this direction, it is true, but the information is scattered broadcast through periodicals, and but little has been attempted to systematise it, the only existing guide being Grote's "List of North American Moths," which is limited to names of species, without even references to where they are described.

But to work at a group of insects without the aid of catalogues and monographs, is like attempting to study a language without the help of a grammar and dictionary. In the work before us, Prof. Smith has amply fulfilled the latter necessity, as far as regards the family of moths of which he treats. The Noctuidæ may be considered the most extensive family of the larger moths. We have 300 species in England, and Staudinger's last "Catalogue of the Lepidoptera of Europe, North Africa, Asia Minor, Siberia, and Labrador," published in 1871, enumerates 1040 species for those countries, and many have been added since; and although Prof. Smith does not number the North American species, an examination of his index yields upwards of 3000 species; and even after making the largest deductions for generic names and synonyms (perhaps too large an allowance), we may still fairly conclude that the Nearctic fauna considerably outnumbers the Palæarctic in this family, though it is not the case in the butterflies.

Prof. Smith has been accumulating materials for a monograph of the North American Noctuidæ for the last ten years. During the course of his studies, he visited London, and made a special study of the important series of type-specimens in the British Museum, which includes a large proportion of those described by Guenée, Walker, and Grote. Consequently he has been able to clear up a good deal of hitherto doubtful synonymy. He has also visited several of the more important museums on the continent, and of course the principal collections in North America had previously been examined by him; therefore his work is not a mere compilation (though even in this case it would have been of great value), but it represents a large amount of original study.

A rather important question discussed by Prof. Smith in his preface, is that of "types." He remarks:—"Dr. Hayen holds that every specimen named by an author of a species described by himself is a type. Mr. Morrison was yet more liberal, and marked as 'type' a number of specimens of species described by Mr. Grote, having presumably compared them with the actual type. Mr. Grote's practice seems to have been to mark all specimens before him when writing his original description, as 'type,' and I think Mr. Grote is right." Our own opinion is that greater precision is necessary, and that no specimen can be considered a type which was not before an author when he drew up his description. Even so, he should always label one individual specimen, which he considers to represent his species best, as "type," and, properly speaking, there cannot be more than two such "types" of a species, male and female. The remainder of the series should be regarded not as "types," but as "co-types," and specimens which are afterwards compared and considered to agree with them, whether compared by the author of the species himself, or by some other person, should simply be labelled "compared with type." Too much precaution cannot be exerted in these matters. Among other subjects noticed in the preface, are the contents of the various collections consulted by Prof. Smith, the dates of Hübner's works (in which he hardly seems to us to be fully acquainted with the published information), and explanations respecting the manner in which he has arranged the details of his book, in quoting references and localities, &c. All the species contained in the United States National Museum at Washington are marked with an asterisk. A useful index to authors and works cited follows the preface, and the general index, which closes the volume, fills twenty-six pages of small print in double columns.

Great differences of opinion exist between Prof. Smith and other American and European entomologists respecting the classification of the Noctuidæ, and sometimes also respecting the identification of various species cited. This is unavoidable, and in no way interferes with the value of his work. In most cases, Prof. Smith indicates where the type specimens of each species are to be found, and frequently adds valuable notes on identification and variation. Transformations are omitted, owing to the late Mr. Harry Edwards having issued a complete catalogue of the early stages of North American Lepidoptera (*Bulletin* No. 35 of the National Museum).

In conclusion, we may venture to express a hope that it may not be very long before Prof. Smith's promised "Monograph of North American Noctuidæ" is ready to see the light. A catalogue is good, but a monograph is better, and we shall be very pleased to see a work of such magnitude and importance carried to a successful conclusion.

W. F. KIRBY.

[1] *Bulletin* of the United States National Museum, No. 44. A Catalogue, bibliographical and synonymical, of the Species of Moths of the Lepidopterous Superfamily Noctuidæ, found in Boreal America, with critical notes by Dr. John B. Smith, Professor of Entomology in Rutger's College. (Washington, 1893.)

NOTES.

Reuter's correspondent at Amsterdam reports that, according to a telegram received from Batavia, there has been an eruption of the volcano of Galoenggoen, near Garoet, in the Preang Regency. Several native villages are said to have been destroyed. The great eruption of this volcano in 1822 involved an enormous loss of life and property.

A severe shock of earthquake is reported by the Central News correspondent at Tokio as having occurred on Monday night in the province of Akita. The centre of the disturbance was apparently the town of Sakata, which was almost entirely destroyed.

We regret to note the death of Mr. Charles Carpmael, the Director of the Meteorological Service of Canada. He died at Hastings on Saturday. The death is also announced of General Robson Benson, whose work in connection with the development of the Botanic Gardens at Madras and Rangoon earned for him the esteem of all botanists; and of Mr. Edwin Clark, the engineer. Mr. Clark was a Fellow of the Royal Astronomical and Meteorological Societies.

We learn from the *American Naturalist* that the Salt Lake Literary and Scientific Association has recently given sixty thousand dollars for the endowment of a chair of Geology in the University of Utah. The chair has been named the Deseret Professorship of Geology, and Dr. J. E. Talmage has been appointed to it.

A correspondent informs us that he recently tested two samples of oxygen supplied for the use of lanternists, and found them to be mixtures of sixty-five per cent. oxygen and thirty-five per cent. nitrogen. Persons who use compressed oxygen should therefore obtain, from the dealer who supplies the gas, some kind of guarantee that it is up to a certain standard of purity.

A very fine auroral display was observed in New Zealand and the south-eastern parts of Australia on August 20. Mr. H. C. Russell writes to us, that at Sydney the south-eastern sky assumed a peculiar green tint at 6.35 p.m. Clouds interfered with his view of the display, and finally blotted out the auroral light and streamers at 8.33 p.m. In New Zealand, the aurora is said to have been very brilliant.

The London and Provincial Ornithological Society will hold their ninth annual show at the Royal Aquarium, Westminster, on Tuesday, Wednesday, and Thursday, October 30, 31, and November 1. The extent of the show may be judged by the fact that over one thousand British and foreign birds will be on view.

The following strange incident is described in the *Times* as having occurred in the reptile-house of the Zoological Society's menagerie, the scene being one of the compartments in which the boa-constrictors are confined. Two large boas occupied the chamber, one snake being nine feet and the other eight feet long. When the house was opened in the morning only one boa was found in this cage; the other had disappeared. Though the survivor was only a foot longer than the other snake, there was no reason to doubt that it had completely swallowed its companion. It was so distended that the scales were almost separated, and it was unable either to coil itself or to move. There is every reason to believe that in accomplishing this almost incredible feat the snake acted by mistake, and that it devoured its companion by what deserves to be called an accident. The larger boa was fed with a pigeon before the house was closed for the night. It swallowed the bird, and the other boa was then given a pigeon, which it had begun to swallow when the snakes were left for the night. It is believed that the larger snake then caught hold of the part of the pigeon which projected from the other's mouth, and gradually enveloped, not only the bird, but the head of the other snake. Once begun, the swallowing process would go on almost mechanically. As the swallowed snake was only one foot less in length than the swallower and of nearly equal bulk, weighing about fifty pounds, the gastric juices must have dissolved the portion which first entered the snake's stomach before the remainder was drawn into the jaws. Though still rather lethargic, the surviving boa is not injured by its meal. It coils itself up without difficulty, and its scales have the beautiful iridescent bloom peculiar to the skin of snakes when in perfect health.

The Committee of the Bexley Cottage Hospital are to be commended for their enterprise. They have induced Mr. Hiram S. Maxim to consent to exhibit his flying machine to the public on Saturday afternoon, November 3, at Baldwin's Park, Bexley, and to give an account of its history, construction, and future. The machine will be run along its track at a high velocity, so there will be an opportunity of judging of its capabilities. Mr. Maxim's workshop will be open to visitors, and his scientific apparatus will be on view. There will also be a practical display of the Maxim automatic machine guns. This method of obtaining funds for hospital work is worth developing. We hope it will meet with the success it deserves. Perhaps the time will soon come when the public will take as much interest in a scientific invention as it does in a good picture.

Two Russian Kalmuks from the lower Volga, one of them a Buddhist priest, have recently spent some time in Thasa, and the *Comptes-rendus* of the Paris Geographical Society expresses the hope that they may be able to make public some interesting facts about the sacred city, from which all Europeans have been rigidly excluded for the last half-century.

The provisional programme issued by the Royal Geographical Society for the Session 1894–5 shows that the Society is responding to the more general interest now being taken by its Fellows in the serious study of geography. The rooms of the Society have been altered and greatly improved, better accommodation being provided for the large collection of maps to which the public has free access, and for the library. A large room has been added to the library for the use of Fellows who wish to carry on special stuly undisturbed. A new series of technical meetings is to be instituted, at which important papers may be discussed by specialists, and the investigation of the scientific aspects of geography encouraged. It has long been felt that the evening meetings did not serve this purpose, the lateness of the hour and the presence of a large general audience preventing anything like technical discussion or detailed criticism. The new afternoon meetings are intended for specialists only, and they will take place in the map-room of the Society as frequently as occasion arises.

Evening lectures will continue to be a prominent feature of the activity of the Royal Geographical Society, and the Session will be opened on November 12 by Mr. H. H. Johnston, C.B., who will speak of the British Central Africa Protectorate, of which he is Administrator. The two following meetings will also be devoted to Africa, Mr. Walter B. Harris giving an account of his recent visit in disguise to the oasis of Tafilet in Southern Morocco, and M. Lionel Decle describing his adventurous journey from the Cape to Uganda. Papers are also promised by Mr. Basil H. Chamberlain on the Luchu Islands, Mr. O. Howarth on the Sierra Madre of Mexico, Mr. D. G. Hogarth on recent explorations in Asia Minor, Mr. G. G. Dixon on North-west British Guiana, Mr. S. Butcher on Luristan, Mr. H. Weld-Blundell on Cyrenaica, Mr. W. M.

Conway on the Alps, their limits, structure, and physiognomy, and Mr. C. Raymond Beazeley on a new Periplus of the Erythrean Sea. Mr. J. Theodore Bent, who starts immediately on a new journey from Oman to Aden across Arabia, hopes to return in time to give an account of his travels. The Christmas lectures to young people will be continued, the lecturer this year being Dr. H. R. Mill, and the subject "Holiday Geography."

WE have received a new instalment of the "Annals" (Eje godnik) of the Russian Geographical Society, vol. iii. 1894, which is on the same high level as the preceding issues of the same series. It contains a review of astronomical, geodetical, and cartographical work done in the year 1892 by the geodetists and topographers of the Ministry of War, and of the hydrographic work done in 1891 by the officers of the Navy. The meteorological and hydrological observations made by officers of the Russian Navy are discussed by P. A. Mordovin; and also the work of the officers of the Ministry of Ways. E. E. Leist gives a review of the work done in the domain of terrestrial magnetism, magnetic anomalies, and magnetic perturbations in Russia; S. N. Nikitin sums up the progress of geological exploration in the Russian Empire; B. Y. Sreznewski deals with the progress of Russian meteorology; and N. I. Kuznetsoff gives an elaborate review of the work done in the domain of botanical geography in Russia, and partly also in West Europe. All these papers are supplied with full bibliographical indexes.

IN the same "Annals," M. Nikitin, who is undoubtedly the highest authority on the Glacial period in Russia, sums up our present knowledge as regards the supposed inter-glacial deposits in East Europe. In his well-known work on the glaciation of Russia, published in 1886, he pointed out that the theory of a double glaciation is utterly inapplicable to that country, and that, if a second glaciation really has existed in Europe, it did not exist in Russia, which must have been free of ice during the period when the ice is supposed to have invaded Europe for a second time. True, a young geologist, M. Krischtafowitsch, announced, in 1891, the discovery of inter-glacial deposits about Moscow, and his article had been quoted in West Europe as a confirmation of the double glaciation theory; but the following year, when his observations were made with greater accuracy, he hastened to recognise that he had too rashly built up his theory. M. Nikitin's opinion is, therefore, that although the whole question cannot yet be considered as finally settled, there are no facts whatever which the theory of an inter-glacial period in East Europe might be built upon; on the contrary, the facts point to a single glaciation.

THE gradual but somewhat tardy recognition of the part played by motor elements in consciousness in the localisation of objects in space, forms an interesting chapter in the history of the progress of psychological interpretation. A valuable contribution to this subject is to be found in a paper on the localisation of sound, by Prof. Münsterberg and Mr. A. H. Pierce, in the current number of the *Psychological Review*. It is based on a careful experimental investigation, and goes far to establish Prof. Münsterberg's theory, that the assigning of direction to sounds rests upon the union of sensations of sound and motor sensations, the latter originating from actual or intended movements of the head in the direction of the sounding body. The paper, which well illustrates the value of experimental research in psychology, deserves the careful attention of all those who are interested in the psychological aspect of the problems of space.

AN investigation that furnishes a new point of view from which to consider the undoubted Arachnid affinities of that morphological puzzle, the American king-crab, *Limulus*, it described in the *Zeitschrift f. wiss. Zoologie*, vol. lviii. part 1 issued last July. The author is Dr. A. Jaworowski, of Lemberg, and he has traced out the development of the so-called "lung" in a spider, *Trochosa singoriensis*. He finds that this organ does not arise directly as such, but is formed in ontogeny by the secondary modification of a true trachea, which consists at first of a funnel-shaped external or stigmatic chamber, a common tracheal stem, and a bundle of delicate terminal tubules, penetrating some distance into the body. The tracheal tubes gradually atrophy, and on the walls of the external chamber or air-sac, which considerably enlarges, arise a number of parallel lamelliform folds, at right angles to the course of the common tracheal stem. From these structures, which in their early stages recall the appearance presented by the transverse striations of the tracheæ in insects, the respiratory lamellæ of the "lung" are derived. Development thus establishes the Tracheate origin of the Arachnida, and opposes the view that the lungs of spiders have arisen as modifications of the gill-books of a *Limulus*-like ancestor; though Dr. Jaworowski holds that the converse of this proposition—that the gill-books of *Limulus* have been evolved by the modification of Arachnid lungs—is very probably true. Simroth's view that *Limulus* is essentially a land animal, secondarily adapted to a marine existence, is thus confirmed; and Dr. Jaworowski does not hesitate, after a discussion of the nature of the Crustacean gill, to derive the whole phylum Crustacea from the Tracheate stem.

HERREN KOHLRAUSCH and Heydweiler appear to have approximated more closely to the preparation of absolutely pure water than any previous observers. In a paper on the subject, published in the current number of *Wiedemann's Annalen*, they describe the manner in which they prepared and tested the samples of pure water. Water distilled in air shows, even with the greatest precautions, an electric conductivity of $0·7 \times 10^{-10}$ at 18°C., mercury being the unit. Distillation in a vacuum of about 0·01 mm. reduces this conductivity to $0·25 \times 10^{-10}$, but into this value the solubility of the glass enters as a disturbing factor. A glass vessel employed for the purpose ten years ago had been constantly kept filled with water, with the result that the value for the conductivity found with what was now practically insoluble glass was as low as $0·04 \times 10^{-10}$. This value was greatly influenced by changes of temperature, being about 0·014 at 0°, and 0·18 at 50°, but this behaviour had been predicted by the theory of dissociation. The authors now endeavoured to find the true conductivity of absolutely pure water by extrapolation, on the basis of the change of the temperature coefficient with increasing impurity, as given by the theory of dissociation. The value thus obtained for the conductivity of absolutely pure water at 18° C. was $0·036 \times 10^{-10}$. It will be seen that the extrapolation only amounted to 10 per cent. The amount of residual impurity was estimated at a few thousandths of a milligramme per litre, which is 10,000 times less than the amount of air normally absorbed from the atmosphere. A curious phenomenon observed in the course of these measurements was the temporary increase of conductivity of the water when the current was of any considerable duration, an increase which sometimes amounted to 100 per cent. The amount of dissociated hydrogen in a cubic metre of water at 18° is calculated to be 0·08 milligrammes, at 0° only 0·036 milligrammes, and at 100° 0·85 milligrammes. Small as are these numbers, they still mean thousands of millions of atoms to the cubic mm., *i.e.* intervals between neighbouring atoms of the order of wave-lengths of light. In our conception, and even in miscroscopic vision, these free atoms of hydrogen would still appear to fill space continuously. That Ohm's law still holds for such a solution is not surprising.

IN a paper contributed to *L'Eclairage Electrique*, Signor L. Palmieri gives an account of the results he has obtained during the last few years in his study of the earth-currents at the Vesuvius Observatory. One of the earth-lines used terminates in a large copper plate buried in a well at the little village of Résina at the base of the mountain, and follows the direction S.W.-N.E. to the Observatory, where it is taken almost vertically down from the observing room and connected with the lightning-conductor. A shorter line has been tried in several azimuths, but has finally been permanently fixed in a N.W. direction from the Observatory. At first an ordinary astatic galvanometer with rather long magnetic needles was used, but it was found that the powerful currents which passed during thunderstorms often demagnetised the needles, or even magnetised them in the reverse direction. The ordinary form of suspended coil D'Arsonval galvanometer was also found to be subject to the objection that if the metallic suspension was sufficiently fine to allow of the small currents ordinarily obtained being recorded, then the large currents sometimes obtained fused the suspension. Finally the author, after consulting with Marianini, designed an instrument which essentially consists of a small electro-magnet the coils of which are connected to the earth-line and a magnetised needle suspended above this magnet. After more than a year of continuous observation, the author had come to the conclusion that the earth-currents were always from the lower station to the higher; but towards the end of August 1893, the currents commenced to vary in direction, and finally settled down in the opposite direction to that they had taken since 1889, when observations were first started. The change in the direction in the earth-currents occurred at a period when the volcano was more than usually active; but in January and February 1894 the volcano became much less active, and the earth-currents first decreased in intensity and then resumed their old upward direction. The activity, however, broke out again, at the central crater this time, and the earth-currents again changed their direction. In every case it has been found that when the volcano is quiescent the earth-currents ascend, but when the volcano's activity increases, the earth-currents at once change their direction and pass from the higher station to the lower. On June 7, 1891, when the lava made its first appearance, it was noticed that the needle of the astatic galvanometer at that time employed was continually in movement; and this movement was very irregular, the needle often behaving as if it had received a sudden blow.

A BRIEF summary of the analytical work required for the practical examinations in inorganic chemistry of the Science and Art Department is given in "A Laboratory Guide and Analytical Tables," by Mr. James Grant (Smith and Wood, Manchester).

THE October number of the *Proceedings* of the Physical Society of London (vol. xiii. part i.) has been published. It contains thirteen papers and six plates. The *Journal* of the Royal Microscopical Society, for October, has also just been issued.

MESSRS. WILLIAMS AND NORGATE have issued the sixtieth number of their scientific book circular, in which are catalogued new scientific publications, mostly of foreign origin, offered for sale by them. A similar catalogue has been received from Mr. J. H. Knowles, Lavender-hill, London, S. W.

THE *Electrician* Printing and Publishing Company are just issuing "Electric Lamps and Electric Lighting," by Dr. J. A. Fleming, F.R.S. The same publishers also announce, as ready shortly, "Electric Motive Power," with chapters specially dealing with the use of electricity in mines for lighting, haulage, pumping, coal-getting, &c. This latter work is by Mr. Albion T. Snell.

UNDER the title "Régularisation des Moteurs des Machines Électriques," M. P. Minel has completed a series of four volumes, which he has written for the Encyclopédie scientifique des Aide-Mémoire, on electricity and its applications to navigation. This new work has recently been published by MM. Gauthier-Villars, and also a volume on "Fortification," by Lieut.-Colonel Hennebert.

MR. ELLIOT STOCK has published a cheap edition of "A Manual of Exotic Ferns and Selaginella," by Mr. E. Sandford. The book comprises descriptions of more than one thousand species and varieties, and upwards of six hundred synonyms, as well as notes on the history, culture, and management of the plants considered. Amateur, and also professional, horticulturists will find the volume useful.

THE Geographical and Geological Commission of São Paulo, Brazil, has for some years published useful climatological data for that province. The last we have received is for the year 1892, and contains monthly and yearly means for twelve stations, and also for Rio de Janeiro, with a good general discussion, of the data for each place, by Sr. Schneider. As this State forms part of the coffee-growing region of Brazil, the publication of these summaries is of interest, both from scientific and commercial points of view.

FOUR lectures on biology, delivered by Dr. R. W. Shufeldt, before the Catholic University of America, in January 1892, have been reprinted from the *American Field*, and published in pamphlet form. The lectures deal with the history and present domain of biology; the relation of biology to geology; the value of biological study; and the growth and future influence of biology. They caused considerable stir at the time, for Dr. Shufeldt did not mince matters in presenting an account of the bearing of Catholicism to early scientific investigation. Nothing can be found in them, however, that is not sustained by the best of evidence.

DR. BÉLA HALLER has revised his numerous researches upon the morphology of Prosobranchiate molluscs, and has incorporated them in the form of a handsome quarto monograph entitled "Studien über Docoglosse und Rhipidoglosse Prosobranchier nebst Bemerkungen über die phyletischen Beziehungen der Mollusken untereinander," published by Engelmann, of Leipzig. The student of molluscan morphology will find there a lucid and admirably illustrated exposition of anatomical data, and will not fail to be stimulated, if only to opposition, by Haller's peculiar views on the phylogeny and inter-relations of the different molluscan groups.

EVERY student of physical chemistry unfamiliar with the German language will welcome a "Manual of Physico-Chemical Measurements" (Macmillan and Co.), translated by Dr. James Walker from Prof. W. Ostwald's standard work. The German edition was reviewed in these columns at the beginning of this year (NATURE, vol. xlix. p. 219), and it was then remarked that the manual was the only guide to measurements in physical chemistry suitable for service in the laboratory. The book is not intended for the beginner, but for the chemist and physicist who desires to become practically acquainted with the region common to both of them. Dr. Walker's admirable translation will doubtless considerably increase the sphere of usefulness of Prof. Ostwald's work.

A SECOND edition of the late Thomas Laslett's classical work on "Timber and Timber Trees" (Macmillan and Co.), completely revised, with numerous additions and alterations, by Prof. Marshall Ward, has just been published. The arrangement of the work has been completely altered, and the numerous advances that have been made in our knowledge of timber and its properties since 1875, when the first edition was published, have been taken into account. The work now consists of four parts. The first part deals with timber in general; in part ii. the timbers of Dicotyledonous trees are considered; part iii. deals with Coniferous timber trees; and the fourth part chiefly consists of tables showing the results of experimental investigations on the physical properties of timber. The book has been of valuable service to the shipwright and carpenter from the time it first appeared; and Prof. Ward's revision has certainly given it a new lease of life.

THE appearance of a second edition of Lord Rayleigh's "Theory of Sound" (Macmillan and Co.) reminds us that the first edition was reviewed in these columns by that eminent investigator, Hermann von Helmholtz, nearly seventeen years ago. Much additional matter has been included in the new edition, and the subject is carried to the limits of the present state of knowledge. Two new chapters have been interpolated, devoted to curved plates or shells, and to electrical vibrations. It was the author's original endeavour to produce "a connected exposition of the theory of sound, which should include the most important of the advances made in modern times by mathematicians and physicists." This object has been borne in mind in the preparation of the new edition. Lord Rayleigh naturally inclines to physical methods of investigation, but purely mathematical solutions are not entirely eschewed. The work has been recognised as a masterly exposition of a difficult subject ever since it first appeared, and the second edition maintains the high standard of the original.

AN important memoir concerning nitrogen trioxide, nitrous anhydride, N_2O_3, is communicated by Prof. Lunge and Herr Porschnew to the current issue of the *Zeitschrift für Anorganische Chemie*. It is claimed that the investigation, whose results are now published, finally disposes of all doubt as to the existence of this much discussed oxide of nitrogen. The main conclusion derived from the work is that nitrogen trioxide is a well characterised individual substance, which is readily formed under ordinary atmospheric pressure below the temperature of $-21°$ by the union of nitric oxide NO and nitrogen peroxide N_2O_4, and constitutes an indigo-blue liquid. It is stated to be perfectly stable at and below this temperature; but at a temperature slightly superior to this, even under pressure, it commences to decompose, and the dissociation is almost complete upon the conversion of the liquid into gas. Nitrous anhydride in a condition of purity thus appears to be incapable of existence in the gaseous state, while forming a comparatively stable liquid at temperatures below $-21°$. The gaseous product of dissociation, a mixture of nitric oxide and peroxide, exhibits similar chemical properties to those which might have been expected of gaseous nitrogen trioxide, hence of course the difficulty which has been experienced in deciding the question. It is pointed out, however, that the absolute incapability of existence of gaseous molecules of nitrogen trioxide is not proved, and the results of the investigation would appear to indicate that a residue of such molecules does escape dissociation upon the passage of the liquid into the gaseous state, and exists side by side with the molecules of the decomposition products. The experiments upon which these conclusions are based are mainly the following. It was first established that nitric oxide and nitrogen peroxide exhibit only the very slightest inclination to unite chemically at the ordinary temperature and at temperatures up to 100°. It was next found that at the temperature of $-21°$ the two oxides combined in practically exactly molecular proportions to form the indigo-blue liquid. The exact amount of N_2O_3 present in one of the specimens analysed is stated to have been 98·3 per cent. The well known work of Ramsay and Cundall upon this subject is, of course, quoted, and it is stated that the apparently small amount of absorption of nitric oxide by liquid nitrogen peroxide, corresponding to only 3·5 per cent. of N_2O_3, observed during that investigation, was due to the loss of weight by mechanical removal of a portion of the nitrogen peroxide in the stream of issuing nitric oxide. It was further demonstrated that the product of the action of oxygen upon nitric oxide gas behaves, particularly towards sulphuric acid, precisely like a mixture, which it probably is, of nitric oxide and nitrogen peroxide. Moreover, the vapour derived from liquid nitrogen trioxide is not stable towards oxygen, but becomes further oxidised until it is almost pure peroxide. The memoir will be found to include an admirable summary of the literature of the subject, together with the views of Prof. Lunge concerning the bearing of the main conclusions of the investigation upon the theory of the sulphuric acid manufacture.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Seymour Willoughby; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mr. H. M. Vincent; a Tiger (*Felis tigris*) from Amoy, China, presented by Mr. Robert Bruce; a Tiger Cub (*Felis tigris*) from Burmah, presented by Mr. John Halliday; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. J. E. Symonds; two Brazillian Caracaras (*Polyborus brasiliensis*) from South America, presented by Lord Lilford; two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Monte Video, presented by the Inns of Court Hotel Company; an Egyptian Jerboa (*Dipus ægyptius*) from Egypt, a Patagonian Conure (*Conurus patagonus*) from La Plata, two Brazilian Cariamas (*Cariama cristata*) from South-east Brazil, deposited.

OUR ASTRONOMICAL COLUMN.

TRIANGULATION OF SIXTEEN STARS IN THE PLEIADES.—In addition to the great interest that has always been attached to this bright group of stars, the Pleiades, as can be gathered from the numerous myths (NATURE, vol. xlix. p. 366) which have been handed down to us, their value to the practical astronomer has been by no means small. In most astronomical measurements, observations have first to be made on stars the positions of which are accurately known, in order to determine the instrumental constants: thus, for instance, the pitch of micrometer screws, ring micrometer constants, &c. The Pleiades, as they consisted of a group of bright stars suitable for such determinations, were constantly used for these purposes, and this necessitated a previous complete knowledge of their positions and motions.

At the present day, however, the stars in the Pleiades group are rather of too bright a nature and too varied in magnitude for very accurate determinations of instrumental constants, and the tendency is now to turn to that group of stars in Perseus, which is more suitable in many respects. A recent triangulation of this region has lately been undertaken by Prof. Wilhelm Schur at Göttingen, with the large heliometer, the results of which appeared in the *Proceedings of the Royal Society of Sciences of Göttingen*. The triangulation to which we wish to refer is of sixteen stars in the Pleiades, and has been made by Dr. Leopold Ambronn at the Göttingen Observatory (*Astronomische Mittheilungen von der Königlichen Sternewarte zu Göttingen*, Bd. xxxix. 3 part).

The instrument employed, a good illustration of which is given, was the small Fraunhofer heliometer, which in earlier times was used in the two Venus Expeditions of this century. It might at first sight seem superfluous to attempt this triangulation with such a small instrument, when we are already acquainted with the results obtained from larger heliometers.

The value of this investigation lies, however, in the very minute determinations of the instrumental constants, and these would be interesting even if nothing more were attempted.

Dr. Ambronn has, however, after making these instrumental constant determinations, measured the positions of sixteen of the Pleiades stars, and compared them with the results obtained from Elkin's new computed values of Bessel's measures made with the Konigsberg heliometer. The following table is of interest, as it brings out the great accuracy of the Göttingen observations, and leads to suggestions regarding the grouping of the stars in numerous systems.

Stars.	Göttingen.—Königsberg. R.A.	Decl.	Relative proper motion for 50 years in Magnitude.	Direction.
	"	"	"	°
g	+0·06	+0·09	0·13	29·0
b	+0·20	+0·42	0·46	23·2
m	−0·66	−0·18	0·63	253·3
e	+0·49	+0·12	0·47	75·1
c	+0·52	+0·07	0·49	81·1
k	+0·01	+0·13	0·14	4·4
l	+0·09	+0·16	0·18	26·6
d	−0·35	−0·06	0·33	259·5
12	−0·60	−0·01	0·55	268·9
η	—	—	—	—
28	+0·12	+0·22	0·25	26·6
s	+1·30	−0·76	1·42	122·5
f	−0·04	−0·16	0·17	194·1
h	+0·04	+0·03	0·05	53·1
34	+0·60	+0·23	0·60	67·3
40	+0·44	+0·50	0·64	38·7

Dr. Ambronn points out that the proper motions appear to show, just as those of Elkin's indicated, that the stars form not one but several systems. As will be seen from the table, *g*, *b*, *k*, *l* (and 28) appear to group themselves together, so also *e* with *c*, and the three stars *m*, *d*, 12, with one another. For a more definite opinion on this point it is suggested that the number of stars observed must be greatly increased.

The result of the triangulation shows, however, that by a suitable determination of the instrumental constants and due care in arranging the measures for reduction, small heliometers can give results, especially with regard to distances, which compare very favourably with instruments of much larger size.

THE FIFTH SATELLITE OF JUPITER.—A series of micrometrical measures of the fifth satellite of Jupiter, made during the opposition of the planet in 1893, is contributed to the *Astronomical Journal*, No. 325, by Prof. E. E. Barnard. From numerous observations, Prof. Barnard is confident that the satellite is not brighter than the thirteenth magnitude. Its sidereal period appears to be 11h. 57m. 22·618s. Filar-micrometer measures of the diameters of Jupiter were made in the course of the work, the following values being obtained:—

Equatorial diameter ... ... 90,190 ± 56 miles.
Polar diameter ... ... 84,570 ± 75 miles.

The polar compression obtained from these measures is 1/15·98. The mean of measures of east elongations of the satellite, made from September 1893 to January 1894, correspond to a distance of 111,910 miles. But on account of the eccentricity and revolution of the orbit of the satellite, the elongation distance is a varying quantity. M. Tisserand was led to conclude, a short time ago, that the major axis of the satellite's orbit must make a complete revolution in about five months. He returns to the subject in *Comptes-rendus* for October 8, having used Prof. Barnard's new measures to make another determination of the eccentricity and the longitude of perijove at a given epoch. His discussion of the observations has led to the following results:—Semi-major axis, 47"·906; eccentricity, 0·0073; longitude of perijove at the epoch October 28, 1892, −14°.

THE PAST SUMMER.

AN examination of the meteorological results for the six months from April to September exhibit some features of interest by way of showing how the several elements of temperature, rainfall, and sunshine combine to make up what is commonly called weather, and how, as in the case of the summer in question, the absence of sunshine can mar the season. In some summers the character of the weather varies considerably in different parts of the kingdom, but during the recent summer there was a great similarity in the conditions over the whole of the British Islands, and consequently the principal facts in the following summary, deduced from observations in the neighbourhood of London, will, to a great extent, be an index for other parts of the kingdom.

Table showing the Temperatures at Greenwich for the several Months and for the whole Summer.

	Mean.	Diff. from average.	Mean of all highest.	Diff. from average.	Mean of all lowest.	Diff. from average.	Warm days.	Cold days.
	°	°	°	°	°	°		
April ...	51·9	+3·8	61·8	+4·6	41·9	+3·0	26	4
May ...	51·8	−2·1	61·1	−3·1	42·5	−1·2	10	21
June ...	59·8	−0·6	69·2	−1·7	50·4	+0·5	11	19
July ...	63·6	0·0	73·0	−1·0	54·1	+1·0	13	18
August..	61·4	−1·5	69·2	−3·6	53·6	+0·6	5	26
Sept. ...	55·2	−3·0	62·2	−5·1	48·1	−1·0	6	24
Summer	57·3	−0·6	66·1	−1·6	48·4	+0·4	71	112

The averages used in the above comparison are for the 50 years 1841 to 1890. A warm day is one on which the mean daily temperature is above the average, and a cold day is one on which the mean daily temperature is below the average.

It will be noticed that the mean maximum temperature is below the average, except in April; while the mean minimum temperature is in excess of the average, except in May and September. The highest day temperatures at Greenwich only reached 70° or above on 51 days, and they were distributed as follows throughout the summer:—April, 3 days; May, 2; June, 12; July, 21; August, 12; and September, 1. There were in all only 7 days with a temperature of 80° or above; they occurred as follows:—June, 3; July, 3; and August 1. For the last 50 years, 1845–1894, there have been on the average 75 days with a temperature of 70° and above, and 15 days with a temperature of 80° and above. The summers of 1860, 1879, and 1888 each had a fewer number of hot days than the summer which has just passed, while 1846, 1857, 1858, 1865, 1868, and 1893 each had double the number of hot days. Last year the mean temperature for the whole summer was more than 3° in excess of the mean for the summer this year, but the summer last year was warmer than any during the last half-century, although it was only 0°·2 warmer than in 1868.

The following table gives the rainfall and sunshine at Greenwich, and the sunshine values at Westminster, for the several months and for the whole summer:—

	Rainfall. Rainy days.	Total amount.	Diff. from average of 40 years.	Hours of bright sunshine. Greenwich.	Westminster.	Diff. from average of 10 years.	Sunless days.
		ins.	ins.				
April	14	1·45	− 0·21	123	122	− 2	4
May	15	1·53	− 0·54	137	152	− 32	2
June	11	2·02	− 0·03	127	155	− 19	2
July	19	3·27	+ 0·87	149	166	− 9	2
August	16	3·04	+ 0·55	114	125	− 39	4
September ...	13	1·27	− 0·98	60	83	− 29	9
Summer	88	12·58	− 0·34	710	803	−130	23

The above figures show that rain fell with great frequency, but the amount was by no means excessive, and, with the exception of July and August, the monthly falls were below the average. A slightly different result is obtained if the comparison is made with the last 50 years, 1845 to 1894, the average total fall in summer for that period being 12·66 inches, which gives a deficiency of 0·08 inch only for the recent summer. During the whole period of 50 years, the summer falls have been deficient in 32 years, and in excess in 18 years; but the amounts in excess are much larger than the amounts in defect. The driest summer was 6·80 inches in 1870, and this was followed by 7·39 inches during the summer of last year, while the wettest summer was 22·03 inches in 1879.

The sunshine, it will be seen, was very largely deficient; and this was the principal feature of the period, the sun being screened by cloud far more than usual throughout the summer. The smaller amount of sunshine at Greenwich in comparison with Westminster is very pronounced.

The following table gives various elements in connection with the weather for the several districts of the United Kingdom, the results being for the six months, April to September, or a period of 26 weeks.

	Cold weeks.	Wet weeks.	Rainy days.	Total rainfall.	Hours of sunshine.
				ins.	
Scotland, N. ...	10	11	100	16·8	829
Scotland, E. ...	12	11	97	15·8	842
England, N.E. ...	11	11	103	13·3	856
England, E. ...	13	15	102	14·9	923
Midland Counties	14	11	89	12·5	860
England, S. ...	13	14	95	15·0	1003
Scotland, W. ...	16	11	93	15·9	946
England, N.W....	15	13	99	15·0	847
England, S.W. ...	13	11	103	18·2	1037
Ireland, N.... ...	15	13	110	15·0	814
Ireland, S.... ...	14	13	98	18·6	859
Channel Islands...	11	15	107	18·6	1131

The frequency of rain is in excess of the average, except in parts of Scotland, and the amount of rain is in excess, except over the northern portion of the kingdom and in the Midland Counties, the total rainfall for the summer in the latter district being two inches short of the average.

The sunshine was generally deficient, although in the north of Scotland there was an excess of nearly 100 hours. The deficiency during the summer amounted to 186 hours in the Channel Islands, 141 hours in the east of England, and 119 hours in the south of England. CHAS. HARDING.

ON MODERN DEVELOPMENTS OF HARVEY'S WORK.[1]

THIS annual meeting in memory of Harvey is usually associated with feelings of pleasure and happiness, for it was intended by its immortal founder to commemorate the benefactors of the College and to encourage good fellowship amongst us.

Such commemoration of those who have benefited the College in the past, although it, necessarily, recalls many who have passed away, is, notwithstanding, on ordinary occasions pleasant instead of painful, because the feeling of loss through their death is completely overpowered by the recollection of the good they have done in their lifetime. To-day the case is very different, for the first thought that must needs occur to every one present here is that on this occasion last year our late President showed for the first time what seemed to be imperfect fulfilment of his duty to the College by being late in his attendance at the meeting. Perhaps nothing else could have shown more clearly his deep concern for the welfare of the College, and his thorough devotion of every faculty of mind and body to its interests, than the fact that no duty, no pleasure, and no press of occupation could tempt him to leave one iota of his work in the College undone. The only thing that did keep him back was the hand of Death, which, although at the last meeting he and we knew it not, was already laid upon him. Though his death was less happy than that of the great Harvey, inasmuch as he lingered on for days instead of hours after he was first struck down, yet their deaths were alike in this respect that, up to the time of the fatal attack, each was in the full possession of his faculties, each was in the enjoyment of his life. Like Radcliffe and Mead, like Halford and Baillie, and like many other distinguished Fellows of this College, the greatness of Clark is to be estimated not by the published works which he has left behind, but by the influence he exerted on his contemporaries. For the very estimation in which his professional skill was held, led to his whole time being taken up in giving advice, and prevented him from having the leisure to work out or record the results of the pathological and clinical observations which both his youthful publications and his later career showed him to be specially fitted to make. I might say very much more about him, but it has already been said much better than I could possibly do it by yourself, Mr. President, in your annual address, and in the eloquent and heart-stirring words which you addressed to the College on the occasion of your taking the presidential chair rendered vacant by the death of Sir Andrew Clark.

But while we are saddened to-day by the death of our late President, we hope to be gladdened by the presence amongst us again of one whom we all reverence not only as a former President of this College, but as one of the greatest leaders of clinical medicine in this century, Sir William Jenner. Like Harvey, Sir William Jenner is honoured by his College, by his country, by his Sovereign, and by the world at large. In times of trial and danger the lives of the Royal children were committed to the keeping of Harvey by his King; and to-day the care not only of her own life, but of that of her nearest and dearest, is committed to Sir William Jenner by his Sovereign, in the full and well-grounded assurance that in no other hands could they be more safe. The great clinician, Graves, wished to have as his epitaph "He fed fevers"; but Jenner has advanced much beyond Graves, and, by showing us how to feed the different kinds of fevers, has saved thousands of valuable lives. To-day this College is acknowledging his right to rank with Sydenham, Heberden, Bright, and Garrod, by bestowing upon him the Moxon medal for clinical research. In numbering Sir William amongst its medallists, the College honours itself as well as him, and in acknowledging the great services he has rendered, it is, on this occasion, acting as the mouthpiece of the medical profession, not only in this country, but in the world at large.

It was with the wish to keep green the memory of the benefactors of the College that this oration was instituted by Harvey, and not at all with the intention that it should be devoted to his own praise. But Harvey stands out so high above all others, that it is only natural that in the numerous orations which have been yearly given before the College of Physicians, the subject-matter should have been, to a great extent, confined to a consideration of Harvey and his works. On looking over many of these orations, I find that everything I could say about Harvey, his person, his circumstances, his character, and his works, has already been said so fully and eloquently that I could not add to it anything further, nor could I hope to express it even so well. I purpose, therefore, to consider to-day some of the modern developments of Harvey's work, more especially in relation to the treatment of diseases of the heart and circulation. There is, I think, a certain advantage in this also, inasmuch as one is apt by considering Harvey's work only as he left it, to overlook the enormous extent to which it now influences our thoughts and actions; and thus to comprehend its value very imperfectly.

As he himself says, "From a small seed springs a mighty tree; from the minute gemmule or apex of the acorn, how wide does the gnarled oak at length extend his arms, how loftily does he lift his branches to the sky, how deeply do his roots strike down into the ground!"[1]

How very minute is the gemmule from which has sprung everything that is definite in medical science, for this gemmule is no other than the idea which Harvey records in these simple words: "I began to think whether there might not be motion as it were in a circle."

Out of this idea has grown all our knowledge of the processes of human life in health and disease, of the signs and symptoms which indicate disease, of the mode of action of the drugs and appliances which we use, and the proper means of employing them in the cure of disease. In the works that have come down to us, we find that Harvey developed his idea physiologically in several directions. He discussed its application to the absorption and distribution of nourishment through the body, the mixing of blood from various parts, the maintenance and distribution of animal heat, and excretion through the kidneys. How far he developed it in the direction of pathology and therapeutics we do not know, as the results of his labours

[1] The Harveian Oration, delivered at the Royal College of Physicians, on October 18, by Dr. T. Lauder Brunton, F.R.S.

[1] "The Works of W. Harvey," Sydenham Society's Edition, p. 320.

on these subjects have, unfortunately, been lost to us by the destruction of his manuscripts during the Civil War.

We are proud to reckon Harvey as an Englishman by birth, but he is far too great to belong exclusively to any country; men of various nations and scattered all over the face of the earth acknowledge him as their teacher, and have played, or are playing, a part in developing his discovery in its various branches of physiology, pathology, pharmacology, semeiology, and therapeutics. Americans, Austrians, Danes, Dutchmen, French, Germans, Italians, Norwegians, Russians and Swedes have all shared in the work, and so numerous are they that it would be impossible for me to name them all. Stephen Hales, however, deserves special mention, for he was the first to measure the pressure of blood in the arteries, and the resistance offered to the circulation of the blood by the capillaries was investigated by Thomas Young, a Fellow of this College, who ranks with Harvey, Newton, and Darwin as one of the greatest scientific men that England has ever produced, and whose undulatory theory has been as fertile of results in physics as Harvey's idea of circulation has been in physiology and medicine.

Harvey's desire that those who had done good work should not be forgotten was founded upon his knowledge of mankind, and of the tendency there is to forget what has already been done by those who have gone before us. The opposite condition often prevails, and the past is glorified at the expense of the present. But sometimes the present is wrongly glorified at the expense of the past, and past work or past benefits are forgotten.

Good examples of this are afforded by physiological views regarding the action of the vena cava and pulmonary veins and the causation of the cardiac sounds. Harvey appears to have thought that the vena cava and pulmonary veins were simply dilated passively by the passage of blood into them; but the fact that they possess a power of independent pulsation was known to Haller,[1] and was brought prominently forward by Senac,[2] who regards the vena cava as the starting-point of the whole circulation. He says: "The vena cava is therefore the first motor cause which dilates the cavities of the heart; it fills the auricles, and extends their walls in every direction."

These observations appear to have been almost forgotten until they were again made independently a few years ago,[3] and in one of the latest and most accurate physiological treatises which now exist, the description of the cardiac cycle is nearly the same as that given by Senac. "A complete beat of the whole heart, or cardiac cycle, may be observed to take place as follows:—

"The great veins, inferior and superior venæ cavæ and pulmonary veins are seen, while full of blood, to contract in the neighbourhood of the heart; the contraction runs in a peristaltic wave toward the auricles, increasing in intensity as it goes."[4]

The pulsation of these veins, however, cannot be a constant phenomenon, or it would have been noticed by such a keen observer as Harvey.

The sounds of the heart were discovered by Harvey, or at least were known to him, for he speaks of the sound caused in the œsophagus of the horse by drinking, and says: "In the same way it is with each motion of the heart, when there is a delivery of blood from the veins to the arteries that a pulse takes place and can be heard within the chest." This observation remained, as far as we know, without any further development until the time of Laennec, who introduced the practice of auscultation; but it was a Fellow of this College, Dr. Wollaston,[5] who first discovered that the muscles during contraction give out a sound; and although many observations were made regarding cardiac murmurs by Corrigan, Bouillaud, and Piorry, it was chiefly by Fellows of this College, Dr. Clendinning, Dr. C. J. B. Williams, and Dr. Todd, that the question was finally settled, and the conclusions at which they arrived are those now accepted as correct, viz. that "the first or systolic sound is essentially caused by the sudden and forcible tightening of the muscular fibres of the ventricle when they contract; and that the second sound which accompanies the diastole of the ventricle depends solely on the reaction of the

1 Haller, "Elementa Physiologiæ," 1757, tome 1, pp. 410 and 399.
2 Senac, "De la Structure du cœur," livre iv. ch. iii. p. 24.
3 *Proc. Roy. Soc.* 1876, No. 172.
4 M. Foster; "Text-book of Physiology," 6th ed. part i. ch. iv. p. 231.
5 Wollaston, "Phil. Trans." 1810, p. 2.

arterial columns of blood in the semilunar valves at the arterial orifices."[1]

Yet in recent discussions regarding the origin of cardiac sounds, little mention has been made of the work of this committee; and, indeed, I first learned of the value of the work from a German source, Wagner's "Handwörterbuch der Physiologie."

The importance of these observations in the diagnosis of heart disease it would be hard to over-estimate. But diagnosis alone is not the aim of the physician, whose object must be to prevent, to cure, or to control disease. A knowledge of physiology may greatly help us to prevent disease, not only of the heart and vessels, but of every member of the body. The control and cure of disease may also be effected by diet and regimen, but it is undoubtedly in many cases greatly assisted by the use of drugs, and is sometimes impossible without them. Harvey knew that drugs applied externally are absorbed and act on the body,[2] so that colocynth thus applied will purge, and cantharides will excite the urine; but the action of drugs when injected into the blood appears to have been tried first by Christopher Wren, better known as the architect of St. Paul's than as a pharmacologist. According to Bishop Spratt, "He was the first author of the noble anatomical experiment of injecting liquors into the veins of animals, an experiment now vulgarly known, but long since exhibited to the meetings at Oxford, and thence carried by some Germans, and published abroad. By this operation divers creatures were immediately purged, vomited, intoxicated, killed, or revived, according to the quality of the liquor injected. Hence arose many new experiments, and chiefly that of transfusing blood, which the Society has prosecuted in sundry instances, that will probably end in extraordinary success."[3]

The method originated by Wren, of injecting drugs into the circulation, was skilfully utilised by Magendie for the purpose of localising the particular part of the body upon which the drugs exerted their action, and he thus conclusively proved that the symptoms produced by strychnine were due to its effect on the spinal cord. His experiments showed that the rate of absorption from various parts of the body varied enormously, and, through the teaching of Christison, led to the introduction into practice by Dr. Alexander Wood of that most useful aid to modern therapeutics, the hypodermic syringe.

The first quantitative experiments on the effect of drugs upon the circulation were made, to the best of my knowledge, by James Blake in 1844, in the laboratory of University College, at the suggestion of the late Prof. Sharpey, with the hæmodynamometer of Poiseulle, which had then been recently introduced.

In speaking about the work of Blake and Sharpey, who are both dead, one requires to use the greatest care not to unduly detract from the merit of one by ascribing more to the other; but those who knew Prof. Sharpey's enormous range of knowledge, his readiness to put it all at the disposal of others, and the influence he exerted upon all who came in contact with him, as well as his unselfishness in making no claim whatever to what was justly his due, will at once recognise how greatly Blake was indebted to Sharpey. More especially is this the case when we consider that, although the credit for the observations themselves belongs to Blake, yet after the impetus which Sharpey gave him had passed away, he did very little more during the course of a long life. It seems all the more necessary to commemorate Sharpey on this occasion because he has left comparatively few writings behind him, and anyone who should judge by them alone of his influence upon physiological progress in this country would grievously underestimate it. For Sharpey was above all a teacher, and his work was written not with pen and ink on paper or parchment, but was engraved upon the hearts and minds of his pupils and friends. Upon two of these, especially, has Sharpey's mantle fallen, and to Burdon Sanderson and Michael Foster we owe a revival of experimental physiology in this country, a revival of the method which Harvey not only used in making his great discovery, but also employed to demonstrate the truth of it to the rulers of this land. By their writings, by their lectures, by their original experiments, by their demonstrations, and by the pupils they have trained, Burdon

1 Report of Committee consisting of C. J. B. Williams, R. B. Todd, and John Clendinning, "Brit. Assoc. Rep. for 1836," p. 155.
2 "The Works of William Harvey," Sydenham Society edition, p. 72.
3 "The History of the Royal Society of London, for the Improving of Natural Knowledge," by Thos. Spratt, late Lord Bishop of Rochester.

Sanderson and Michael Foster, under the auspices of Acland and Humphrey, have diffused amongst the medical men of this country a knowledge of physiology so extensive and exact as could only be found, before their time, amongst those who had made a special study of the subject. Yet more than to them, more than to anyone else since the time of Harvey, do we owe our present knowledge of the circulation to Carl Ludwig. He it is who first enabled the pressure of blood in the arteries to record its own variations automatically, so that alterations could be noticed and measured which were too rapid or too slight to be detected by the eye. To him, also, we owe the plan of artificial circulation by which the changes in the functions of the organs and in the vessels which supply them can be observed, quite apart from the heart, lungs, or from the nervous system.

Like Sharpey, Ludwig is a great teacher, and like the great architects of the Middle Ages, who built the wonderful cathedrals which all admire, and the builder of which no man knows, Ludwig has been content to sink his own name in his anxiety for the progress of his work, and in his desire to aid his pupils. The researches which have appeared under these pupils' names have been in many instances, perhaps in most, not only suggested by Ludwig, but carried out experimentally with his own hands, and the paper which recorded the results finally written by himself. In the papers which have appeared under his pupils' names we find their obligations to the master recorded in such terms as "unter Mitwirkung." But no one, except those who have worked with him, can understand what such co-operation meant.

The graphic method introduced by Ludwig for the purpose of measuring the blood pressure, was adapted by Volkmann to the registration of the pulse in man, and the same method has been modified and rendered more easily applicable at the bedside by Marey and Chauveau, to whom we chiefly owe our knowledge of the modifications in the form of the apex beat, and of the pulse curve. It is to Ludwig and his scholars, however, that we owe the greater part of our knowledge of the mechanism of the circulation, and of the varying distribution of the blood in various parts of the body.

The effect of emotion upon the heart was carefully noted by Harvey, who says: "For every affection of the mind which is attended with pain or pleasure, hope or fear is the cause of an agitation whose influence extends to the heart." [1]

Not only was Harvey well acquainted with the fact that the beats of the heart vary very much in strength and force, but he also knew that the circulation in various parts of the body may be very different at one and the same time. He says: "It is manifest that the blood in its course does not everywhere pass with the same celerity, neither with the same force in all places, and at all times, but that it varies greatly according to age, sex, temperament, habit of body, and other contingent circumstances, external as well as internal, natural or non-natural. For it does not course through intricate and obstructed passages with the same readiness that it does through straight, unimpeded and pervious channels. Neither does it run through close, hard, and crowded parts, with the same velocity as through spongy, soft, and permeable tissues. Neither does it flow and penetrate with such swiftness when the impulse (of the heart) is slow and weak, as when this is forcible and frequent, in which case the blood is driven onwards with vigour, and in large quantity."

"And what, indeed, is more deserving of attention than the fact that in almost every affection, appetite, hope, or fear, our body suffers, the countenance changes, and the blood appears to course hither and thither. In anger the eyes are fiery and the pupils contracted; in modesty the cheeks are suffused with blushes; in fear, and under a sense of infamy and of shame, the face is pale, but the ears burn as if for the evil they heard or were to hear; in lust, how quickly is the member distended with blood and erected." [2]

Harvey's great contemporary, Milton, though so violently opposed to him in politics, would certainly not remain in ignorance of Harvey's work, and he has noted the changes in the colour of the face produced by emotions. In describing the behaviour of Satan on his journey from Hell to Paradise, he says:—

> "Thus while he spake, each passion dimm'd his face,
> Thrice changed with pale—ire, envy, and despair;
> Which marr'd his borrow'd visage." [3]

[1] "The Works of William Harvey," Sydenham Society's edition, p. 70.
[2] *Ibid.*, p. 128-129.
[3] "Paradise Lost," by John Milton, Book iv., p. 85.

But although these facts were known to Harvey so long ago, it is only in comparatively recent years that the mechanism by which they are brought about has been investigated, and it is only within the last decade that physiologists have begun regularly to believe that the cardiac muscle has a power of rhythmic pulsation independent of its nerves, although Harvey had noted that when the heart was cut into small pieces the fragments would still continue to pulsate. We may fairly, indeed, compare the movements of the heart, as regarded by physiologists of the present day, to those of a horse which is capable of going independently, although its pace may be slowed or accelerated by the reins or spur of the rider. The power of the vagus to act as a rein to the heart, and slow its movements, or stop them altogether, was first noted by Edward and Ernest Heinrich Weber, while the effect that it sometimes has of accelerating instead of slowing, like the effect of shaking the reins of the horse, was observed by Schiff, Moleschott, and Lister.

The accelerating nerves of the heart, and the position of the nerve-centre from which they spring, were more thoroughly investigated by von Bezold,[1] while the power of the vagus to weaken as well as slow the heart was observed by Gaskell. The position of the cardiac centre, which, like the rider, regulates the movements of the heart, was located in the medulla oblongata chiefly by Ludwig and his scholars. Like the heart, the vessels also are regulated in diameter by the nervous system in accordance with the wants of the body generally; and the effect upon the vaso motor nerves which, when cut, allow them to dilate, and when stimulated cause them to contract, was discovered by Bernard, Brown-Séquard, and by our countryman, Waller; while the power of other nerves to cause immediate dilatation was discovered by Bernard, Eckhardt, and Ludwig in the submaxillary glands, penis, and peripheral vessels respectively.

The heart, when cut out of the body, still continues to beat, and the transmission of excitation from one cavity to another was experimented on by Paget, although removed completely from the influence of the central nervous system, and the vessels have a somewhat similar power of independent contractility. The alterations produced in the circulation generally and locally by the contractile power of the vessels, and the changes caused in the vessels by the central nervous system, by peripheral stimulation of the nerves, or by variations in the quality of the blood, have formed the subject of a series of researches extending over many years; and though originated, and in many cases entirely conducted, by Ludwig, have appeared to a great extent under the names of his pupils. The starting-point of these investigations was an examination of the changes in the blood as it flowed through isolated organs, with the view of ascertaining in what manner the combustion by which the animal heat is maintained was effected in the body. While keeping up the circulation of blood through the vessels of muscles severed from the body, Ludwig and Sczelkow[2] observed variations in the flow which appeared to indicate contractile power in the vessels themselves. This research was carried on under Ludwig's direction by various of his scholars in succession, Alexander Schmidt, Dogiel, Sadler, myself, Hafiz, Lépine, A. Mosso, von Frey, and Gaskell. Their observations, as well as those of Cohnheim and Gunning, have shown that the muscular fibres of the arterioles, not only in the muscles but throughout the body generally, have a power of independent and sometimes rhythmical contraction and relaxation. Their contractility is, however, controlled by the central nervous system in accordance with the wants of the body generally. For the amount of blood contained in the body is insufficient to fill the whole of the vascular system at once; and when the vessels are fully dilated, as they are after death, we find that nearly the whole of the blood of the body may be contained in the veins alone. It is, therefore, necessary that when one part of the body is receiving a larger supply of blood, another should be receiving a smaller supply; and the functions of the vaso motor centres have been well compared by Ludwig to the turncocks in a great city, who cut off the water supply from one district at the same time they turn it on to another. Thus it is that when the brain is active the feet may get cold, and Mosso has shown this in an exceedingly neat manner by placing a man on a large board delicately balanced at its centre, and demonstrating that

[1] Von Bezold "Untersuchungen über die Innervation des Herzens," 1863. Leipzig: Engelmann.
[2] Ludwig and Sczelkow, "Henle and Pfeuffers Zeitschrift," 1863, vol. 17, p. 106 and *vide* p. 122.

whenever the man began to think, the increased supply of blood to his brain caused the head to go down and the heels to rise up. A similar condition was indicated by Mayow, who gave a different explanation. He said that the vital spirits were not able to be in the same place at once, and therefore it happens that if a man eats a heavy meal, he is apt to become drowsy, because the vital spirits descend from the brain to the stomach in order to carry on digestion; and, on the other hand, if a man thinks vigorously after dinner, the vital spirits have to leave the stomach to go to the brain, and consequently digestion is imperfectly performed. If we substitute the word blood for vital spirits, we have an exact expression of present physiological ideas.

Ubi stimulus ibi affluxus was an old doctrine and expressed a great truth. Wherever the need for increased nourishment or increased supply of oxygen exists in the healthy body, thither does the blood flow in larger quantities than usual. If the glands are active, their blood supply is greatly increased, as was shown by Bernard, and a similar occurrence takes place in the contracting muscle, as has been shown by Ludwig and his scholars. The vessels of the intestines and of the skin, with their numerous glands, have their calibre regulated by the vaso motor nerves which proceed from the centre in the medulla oblongata. This centre acts most readily upon the vessels of the intestine, and rather less readily on those of the skin. In consequence of this, when the centre is irritated, the vessels of the intestine contract and drive the blood through the skin, so that it is warmer than before, and it is only when the stimulation is very great that the vessels of both contract so that the skin receives less blood than normal, and becomes colder than before. But if the vessels of the skin and intestine are both contracted, where does the blood go? This question was put by Ludwig, and answered by the experiments which he made with Hafiz. It is evident that if the heart be stopped while the blood pressure is being measured in the artery of an animal, the pressure will fall regularly and steadily, because the blood is flowing out all the time through the arterioles and capillaries into the veins. One would naturally expect that if the arterioles were contracted by irritation of the vaso motor centres in the medulla, the fall of blood pressure would either not take place at all, or would be very much slower than before; but on trying the experiment, Ludwig and Hafiz found, to their surprise, that the blood pressure fell almost as quickly as when the vaso motor centre was left alone, and the vessels of the skin and intestine therefore remained uncontracted. In other words, the vessels which supply the muscles of the body and limbs are capable of such extension that when fully dilated they will allow the arterial blood to pour through them alone nearly as quickly as it usually does through the vessels of the skin, intestine, and muscles together. This observation, it seems to me, is one of the greatest importance, and one that has hardly received as yet the attention which it merits.

It is obvious that contraction of the cutaneous vessels, such as occurs upon exposure to cold, will drive more blood through the muscles, and as oxidation goes on more rapidly in them the result will be increased production of heat.

The experiments I have just mentioned show that the vessels of the muscles are not controlled by the vaso motor centre in the medulla oblongata in the same way as those of the intestine and skin. How far their vascular centres may be associated with those for voluntary movements, which have been so admirably localised by Ferrier in the cerebral cortex, still remains to be made out. The circulation through the muscles is indeed a complex phenomenon, and it was shown by Ludwig and Sadler to depend upon at least two factors having an antagonistic action. When a muscle is thrown into action, it mechanically compresses the blood vessels within it, and thus tends to lessen the circulation through it, but at the same time the stimulus which is sent down through the motor nerve, and which calls it into action, brings about a dilatation of the vascular walls, and thus increases the circulation through the muscle.

When the amount of blood is measured before, during, and after stimulation of its motor nerves, it is sometimes found that the flow is diminished, at others that it is increased, the alteration depending upon the comparative effect of the mechanical compression of the vessels of the muscles just mentioned, and upon the increase of their lumen by the dilatation of their walls. It invariably happens, however, that after the muscle has ceased to act, the flow of blood through the muscle is increased. This increase is quite independent of any alteration in the general pressure of blood in the arteries, and it occurs when an artificial stream of blood, under constant pressure, is sent through the muscle. The dilatation in the muscular vessels, as indicated by the increased flow of blood, and consequent change of colour in the frog's tongue, was observed by Lépine after stimulation of the peripheral ends of the hypoglossal and glossopharyngeal nerves, and the actual changes in the vessels themselves were observed microscopically by von Frey and Gaskell.

The dilatation of muscular vessels on irritation of peripheral nerves was thus brought into a line with the dilatation noticed in the vessels of the submaxillary gland by Bernard, and in the corpora cavernosa by Eckhart. It is evident that alteration in the size of such a huge vascular tract as the muscular arteries must influence, to a great extent, the blood pressure in the arteries generally, and it is equally evident that the changes induced in the condition of the blood pressure by muscular action may be of two kinds, either a rise or a fall. If the arterioles are compressed by the muscles so that the flow through them is impeded, the general blood pressure will rise. When this effect is more than counteracted by the dilatation of the arterioles themselves under nervous influence the general blood pressure will fall, for the blood will find an easy passage through the vessels from the arteries into the veins. We can thus see how readily a rise or fall in the general blood pressure may be induced by exercise of the muscles. If they contract suddenly or violently they will tend to compress the arterioles, and raise the blood pressure, while quite easy contraction will have little effect in compressing the arterioles, and these, becoming dilated, will allow the blood pressure to fall.

But there is still another factor which may tend to increase the blood pressure during severe muscular exertion, viz. a quickened pulse for stimulation of the nerve fibres extending from the muscles to the central nervous system greatly accelerates the beats of the heart. In this respect stimulation of the muscular nerves differs from that of the cutaneous and visceral nerves, inasmuch as the latter tend rather to slow than to quicken the pulse. The peculiar effect of the muscular nerves upon the heart would, indeed, appear to be a provision of nature for the purpose of maintaining an exceedingly active circulation during the active calls upon nutrition which violent exertions entail. Muscular exercise, therefore, has a special tendency to raise the blood pressure in the arterial system, and consequently to increase the resistance which the left ventricle has to overcome. Moreover, in the case of the intestinal vessels there is a special provision made for preventing their contraction from causing too great a rise of arterial pressure. This consists in the depressor nerve, which passes from the heart and tends to produce dilatation of the abdominal vessels, and thus prevent any undue pressure occurring within the heart from their excessive contraction.

In the case of the muscles, we have no such nerves. Its place seems to be taken by the dilating fibres which occur in the motor nerves. As I have already said, however, this effect of dilatation in the muscular vessels may be at first more than counteracted by mechanical compression at the commencement of exertion, and thus the blood pressure in the arteries, and the resistance which it opposes to the contraction and emptying of the ventricle, may be unduly increased.

As a general rule, the distension of any hollow muscular organ is attended with great pain. How great is the suffering when obstruction of the bowel prevents evacuation of its contents; or when a calculus, in its passage down the gall duct or ureter, forcibly distends their wall. One of the severest tortures of the Middle Ages was to distend the stomach with water, and the Emperor Tiberius could imagine no more awful punishment for those whom he hated than to make them drink wine, and, at the same time, by means of a ligature, to prevent the distended bladder from emptying itself. The heart is no exception to this rule, and distension of its cavities brings on most acute physical suffering. Its inability to empty itself is a question of relative, and not of absolute, power; for a strong heart may be unable to work only against enormously increased resistance in the peripheral arterioles, while the heart, weakened by degeneration, may be unable to empty itself in face of pressure little, if at all, above the normal.

When the contractile power of the heart is not, as it is in health, considerably in excess of the resistance opposed to it in vessels, but only nearly equal to it, a slight increase in the resistance may greatly interfere with the power of the heart to empty itself, and bring on pain varying in amount from slight uneasiness to the most intense agony in angina pectoris.

This is, indeed, what we find, for a heart whose nutrition has been weakened by disease of the arteries, and consequent imperfect supply of blood to the cardiac muscle, is unable to meet any increased resistance if this should be offered to it, and pain is at once felt. In such cases, unless they be far advanced, we find, precisely as we might expect, that walking on the level usually causes no pain, but the attempt to ascend even a slight rise, by which the muscles are brought into more active exertion, brings on pain at once. Yet here again we find, as we should expect, that if the patient is able to continue walking, the pain passes off and does not return. These phenomena would be inexplicable were it not for Ludwig's observations on circulation through the muscles, but in the light of these observations everything is made perfectly intelligible. Walking on the flat, by causing no violent exertion of the muscles, produces no mechanical constriction of the vessels, and thus does not increase the blood pressure. The greater exertion of walking up a hill has this effect, but if the patient is able to continue his exertions, the increased dilatation of the vessels—a consequence of muscular activity—allows the pressure again to fall, and relieves the pain.

As muscular exertion continues and the vessels of the muscles become dilated, the flow of blood from the arteries into the veins will tend to become much more rapid than usual. The pressure in the arterial system will consequently fall, but that in the veins will become increased, and unless a corresponding dilatation occurs in the pulmonary circulation, blood will tend to accumulate in the right side of the heart, the right ventricle will be unable to empty itself completely, shortness of breath will arise, and even death may occur. At first the right side of the heart is affected, and the apex beat disappears from the normal place and is felt in the epigastrium, but the left ventricle also becomes dilated, though whether this is simply through nervous influence tending to make it act concordantly with the right, or for some other reason, it is at present impossible to say. Severe exertion, even for a few minutes, may produce this condition in healthy persons,[1] and when the exertion is over-continued it may lead to permanent mischief. More especially is this the case in young growing boys, and it is not merely foolish, it is wicked to insist upon boys engaging in games or contests which demand a long-continued over-exertion of the heart, such as enforced races and paper-chases extending over several miles. Intermittent exertion, either of a single muscle or of a group of muscles, or of the whole body, appears to lead to better nutrition and increased strength and hypertrophy, but over-exertion, especially if it continues, leads to impaired nutrition, weakness, and atrophy. If we watch the movements of young animals, we find that they are often rapid, but fitful and irregular and varied in character, instead of being steady, regular, and uniform. They are the movements of the butterfly, and not of the bee. The varied plays of childhood, the gambols of the lamb, and the frisking of the colt, are all well adapted to increase the strength of the body without doing it any injury; but if the colt, instead of being allowed to frisk at its own free will, is put in harness, or ridden in races, the energy which ought to have gone to growth is used up by the work, its nutrition is affected, its powers diminished, and its life is shortened. The rules which have been arrived at by the breeders of horses ought to be carefully considered by the teachers of schools, and by the medical advisers who superintend the pupils.

In youth and middle age every organ of the body is adapted for doing more work than it is usually called upon to do. Every organ can, as it is usually termed, make a spurt if required; but as old age comes on this capacity disappears, the tissues become less elastic, the arteries become more rigid and less capable of dilating and allowing freer flow of blood to any part, whether it be the intestine, the skin, the brain, the muscles, or the heart itself. Mere rigidity of the arteries supplying the muscles of the heart will lessen the power of extra exertion, but if the vessels be not only rigid, but diminished in calibre, the muscles of the limbs and the heart itself will be unfit even for their ordinary work, and will tend to fail on the slightest over-exertion. This fact was noticed by Sir Benjamin Brodie, who, when speaking of patients with degenerating and contracted arteries, such as lead to senile gangrene, said: "Such patients walk a short distance very well, but when they attempt more than this, the muscles seem to be unequal to the task, and they can walk no further. The muscles are not absolutely paralysed, but in a state approaching to it. The cause of all this is sufficiently obvious. The lower limbs require sometimes a larger and sometimes a smaller supply of blood. During exercise a larger supply is wanted on account of the increased action of the muscles; but the arteries being ossified or obliterated, and thus incapable of dilatation, the increased supply cannot be obtained. This state of things is not peculiar to the lower limbs. Wherever muscular structures exist the same cause will produce the same effect. Dr. Jenner first, and Dr. Parry, of Bath, afterward, published observations which were supposed to prove that the disease which is usually called "angina pectoris depends on ossification of the coronary arteries. . . . When the coronary arteries are in this condition they may be capable of admitting a moderate supply of blood to the muscular structure of the heart; and as long as the patient makes no abnormal exertion, the circulation goes on well enough; when, however, the heart is excited to increased action, whether it be during a fit of passion, or in running, or walking upstairs, or lifting weights, then the ossified arteries being incapable of expanding so as to let in the additional quantity of blood, which, under these circumstances, is required, its action stops and syncope ensues; and I say that this exactly corresponds to the sense of weakness and want of muscular power which exists in persons who have the arteries of the legs obstructed or ossified."[1]

But the syncope and stoppage of the heart mentioned by Brodie are not the only consequences of impaired cardiac nutrition. The heart may be still able to carry on the circulation, but the patient may suffer intense pain in the process. The outside of the heart was found by Harvey to be insensible to light touches, but the inside of the heart appears to be much more sensitive either to touch or pressure.

A knowledge of the mode of circulation of blood through the muscles enables us to understand not only the pathology of angina pectoris, but the rationale of various methods of treating patients suffering from angina pectoris or other forms of heart disease. In most cases, our object is a twofold one—to increase the power of the heart, and to lessen the resistance it has to overcome. In some cases, we require also to aid the elimination of water which has so accumulated as to give rise to œdema of the cellular tissues, or dropsy of the serous cavities. In our endeavours to produce these beneficial changes in our patients, we employ regimen, diet, and drugs, and it is evident that as in one case the condition of a patient's heart may be very different indeed from that in another, the regimen which may be useful to one may be fatal to the other. We have already seen that sudden and violent exertion may raise the blood pressure, and so lead to intense cardiac pain or to stoppage of the heart and instant death; while more gentle exercises, by increasing the circulation through the muscles, may lessen the pressure and give relief to the heart.

The methods of increasing the muscular circulation may be roughly divided into three, according as the patient lies, stands, or walks. First, absolute rest in bed with massage;[2] second, graduated movements of the muscles of the limbs and body while the patient stands still; third, graduated exercises in walking and climbing.

The second of these methods has been specially worked out by the brothers Schott, of Nauheim, and the third is generally connected with the name of Oertel. It is obvious that in cases of heart disease where the failure is great and the patient is unable even to stand, much less to walk, where breathlessness is extreme and dropsy is present or is advanced, the second and third methods of treatment are inapplicable. It is in such cases that the method of absolute rest in bed, not allowing the patient to rise for any purpose whatever, hardly allowing him to feed himself or turn himself in bed, proves advantageous. The appetite is usually small, the digestion imperfect, and flatulence troublesome; and here an absolute milk diet, like that usually employed in typhoid fever, is often most serviceable, being easily taken and easily digested, while the milk sugar itself has a diuretic action, and tends to reduce dropsy. But while simple rest prevents the risk of increased arterial tension and consequent opposition to the cardiac contractions which might arise from muscular exertion, such benefits as would accrue from muscular exertion and increased circulation would be lost were it not that they can be supplied artificially by massage.

[1] Schott. Verharndl. des IX. Congresses in Med. zu Wien, 1890.

[1] "Lectures on Pathology and Surgery," by Sir Benjamin Brodie. (London, 1846, p. 360.)

[2] *Practitioner*, vol. li., p. 190.

This plan of treatment, although it has only recently been revived, was known to Harvey, who narrates the case of a man who, in consequence of an injury—of an affront which he could not revenge—was so overcome with hatred, spite, and passion that "he fell into a strange disorder, suffering from extreme compression and pain in the heart and breast, from which he only received some little relief at last when the whole of his chest was pummelled by a strong man, as the baker kneads dough."[1]

This was a very rough form of massage, but the same kneading movements which Harvey described have been elaborated into a complete system, more especially by Ling in Sweden, and made widely known in America and this country by Weir-Mitchell, and Playfair. One might naturally expect that kneading the muscles would increase the circulation through them in somewhat the same way as active exercise, but, to the best of my knowledge, no actual experiments existed to prove this, and I accordingly requested my friend and assistant, Dr. Tunnicliffe, to test the matter experimentally. The method employed was, in the main, the same as that devised by Ludwig, and employed by Sadler and Gaskell under his direction. The results were that, during the kneading of a muscle the amount of venous blood which issued from it was sometimes diminished and sometimes increased; that just after the kneading was over the flow was diminished, apparently from the blood accumulating in the muscle, and this diminution was again succeeded by a greatly increased flow exactly corresponding to that observed by Ludwig and his scholars.

The clinical results are precisely what one would expect from increased circulation in the muscles, and cases apparently hopeless sometimes recover most wonderfully under this treatment. For patients who are stronger, so that confinement to bed is unnecessary, and who yet are unable to take walking exercise, Schott's treatment is most useful, and it may be used as an adjunct to the later stages of the treatment just described, or as a sequel to it. Here the patient is made to go through various exercises of the arms, legs, and trunk with a certain amount of resistance, which is applied either by the patient himself setting in action the opposing muscles, or by an attendant who gently resists every movement made by the patient, but graduates his resistance so as not to cause the least hurry in breathing, or the least oppression of the heart. Perhaps the easiest way of employing graduated resistance is by the ergostat of Gärtner, which is simply an adaptation of the labour crank of prisons, where the number of turns of a wheel can be regulated in each minute, and the resistance which is applied by a brake may be graduated to an ounce. The objection to it is the uniformity of movement and its wearisome monotony. Oertel's plan of gradually walking day by day up a steeper and steeper incline, and thus training the muscles of the heart, is well adapted for stronger persons, but when applied injudiciously, may lead, just like hasty or excessive exertion, to serious or fatal results. In Schott's method stimulation of the skin by baths is used as an adjunct, and this may tend to slow the pulse, as already mentioned. But in all these plans the essence of treatment is the derivation of blood through a new channel, that of the muscular vessels, and the results in relieving cardiac distress and pain may be described in the same words which Harvey employs in reference to diseases of the circulation: "How speedily some of these diseases that are even reputed incurable are remedied and dispelled as if by enchantment."[2]

There is yet another consequence of the circulation to which Harvey has called attention, although only very briefly, which has now become of the utmost importance, and this is the admixture of blood from various parts of the body. After describing the intestinal veins, Harvey says: "The blood returning by these veins and bringing the cruder juices along with it, on the one hand from the stomach, where they are thin, watery, and not yet perfectly chylified; on the other, thick and more earthy, as derived from the fæces, but all pouring into this splenic branch, are duly tempered by the admixture of contraries."[3]

Harvey's chemical expressions are crude, for chemistry as a science only began to exist about a century and a half after Harvey's death, yet the general idea which he expresses in the words which I have just quoted is wonderfully near the truth.

Two of the most important constituents of the blood are chloride of sodium and water. Chloride of sodium is a neutral salt, but during digestion both it and water are decomposed in the gastric glands, and hydrochloric acid is poured into the stomach, while a corresponding amount of soda is returned into the blood, whose alkalinity increases *pari passu* with the acidity of the stomach. Part of this alkali is excreted in the urine, so that the urine during digestion is often neutral or alkaline. Possibly some of it passes out through the liver in the bile, through the pancreas and intestinal glands into the intestine, where, again mixing with the acid chyle from the stomach, neutralisation takes place, so that neutral and comparatively inactive chloride of sodium is again formed from the union of active alkali and acid. But it is most probable that what occurs in the stomach occurs also in the other glands, and that it is not merely excess of alkali resulting from gastric digestion which is poured out by the liver, pancreas and intestine, but that these glands also decompose salts, pour the alkali out through the ducts, and return the acid into the blood.

We are now leaving the region of definite fact and passing into that of fancy, but the fancies are not entirely baseless, and may show in what directions we may search out and study the secrets of nature by way of experiment. For what is apparently certain in regard to the decomposition of chloride of sodium in the stomach, and probably in the case of neutral salts in the pancreas and intestine, is also probable in that important, though as yet very imperfectly known, class of bodies which are known as zymogens. Just as we have in the stomach an inactive salt, so we have also an inactive pepsinogen, which, like the salt, is split up in the gastric glands, and active pepsine is poured into the stomach. But is the pepsine the only active substance produced? Has no other body, resulting from decomposition of the pepsinogen, been poured into the blood while the pepsine passed into the stomach? Has the inactive pepsinogen not been split up into two bodies active when apart, inactive when combined? May it not be fitly compared, as I have said elsewhere, to a cup or glass, harmless while whole, but yielding sharp and even dangerous splinters when broken, although these may again be united into a harmless whole?[1]

This question at present we cannot answer, but in the pancreas there is an indication that something of the kind takes place, for Lépine has discovered that while this gland pours into the intestine a ferment which converts starch into sugar, it pours through the lymphatics into the blood another ferment which destroys sugar. Whether a similar occurrence takes place in regard to its other ferments in the pancreas, or in the glands of the intestine, we do not know, nor do we yet know whether the same process goes on in the skin, and whether the secretion of sweat, which is usually looked upon as its sole function, bears really a relationship to cutaneous activity similar to that which the secretion of bile bears to the functions of the liver. There are indications that such is the case, for when the skin is varnished, not only does the temperature of the animal rapidly sink, but congestion occurs in internal organs, and dropsy takes place in serous cavities, while in extensive burns of the skin rapid disintegration of the blood corpuscles occurs. It is obvious that if this idea be at all correct, a complete revolution will be required in the views we have been accustomed to entertain regarding the action of many medicines. In the case of purgatives and diaphoretics, for example, we have looked mainly at the secretions poured out after their administration for an explanation of their usefulness, whereas it may be that the main part of the benefit that they produce is not by the substances liberated through the secretions they cause, but by those returned from the intestine and skin into the circulating blood.

How important an effect the excessive admixture of the juices from one part of the animal body with the circulating blood might have, was shown in the most striking way by Wooldridge. He found that the juice of the thyroid gland, though it is harmless while it remains in the gland, and is probably useful when it enters the blood in small quantities in the ordinary course of daily life, yet if injected into the blood, will cause it to coagulate almost instantaneously and kill the animal as quickly as a rifle bullet. What is powerful for harm is, likewise, powerful for good in these cases, and the administration of thyroid juice in cases of myxœdema is one of the most remarkable therapeutic discoveries of modern times. Since the introduction by Corvisart of pepsine

[1] "The Works of William Harvey," Sydenham Society's Edition, p. 128.
[2] *Ibid.*, p. 141.
[3] *Ibid.*, p. 75.

[1] *Practitioner*, vol. xxxv. August 1885.

as a remedy in dyspepsia, digestive ferments have been largely employed to assist the stomach and intestine in the performance of their functions, but very little has been done until lately in the way of modifying tissue changes in the body by the introduction of ferments derived from solid organs. For ages back savages have eaten the raw hearts and other organs of the animals which they have killed, or the enemies they have conquered, under the belief that they would thereby obtain increased vigour or courage; but the first definite attempt to cure a disease by supplying a ferment from a solid non-glandular organ of the body was, I believe, made in Harvey's own hospital by the use of raw meat in diabetes.[1] It was not, however, until Brown-Séquard recommended the use of testicular extract, that the attention of the profession became attracted to the use of extracts of solid organs. Since then extract of thyroid, extract of kidney, extract of supra renal capsule have been employed; but even yet they are only upon their trial, and the limits of their utility have not yet been definitely ascertained.

But yet another therapeutic method has been recently introduced which bids fair to be of the utmost importance, the treatment of disease by antitoxins. The discovery by Pasteur of the dependence of many diseases upon the presence of minute organisms may be ranked with that of Harvey, both in regard to the far-reaching benefits which it has conferred upon mankind, and for the simplicity of its origin. The germ of all his discoveries was the attempt to answer the apparently useless question: "Why does a crystal of tartaric acid sometimes crystallise in one form and sometimes in another?" From this germ sprung his discovery of the nature of yeast and of those microbes which originate fermentation, putrefaction, and disease. These minute organisms, far removed from man as they are in their structure and place in nature, appear in some respects to resemble him in the processes of their growth and nutrition. They seem, indeed, to have the power of splitting up inactive bodies into substances having a great physiological or chemical activity. From grape sugar, which is comparatively inert, they produce carbonic acid and alcohol, both of which have a powerful physiological action. From inert albumen they produce albumoses having a most powerful toxic action, and to the poisonous properties of these substances attention was for a while alone directed. But it would appear that at the same time they produce poisons they also form antidotes, and when cultivated without the body, and introduced into the living organism, they give rise to the production of these antidotes in still greater quantity.

The plan of protection from infective diseases, which was first employed by Jenner in small-pox, is now being extended to many other diseases, and the protective substances which are formed in the body, and their mode of action, are being carefully investigated. The introduction either of pathogenic microbes or of toxic products appears to excite in the body a process of tissue change by which antitoxins are produced, and these may be employed either for the purpose of protection or cure. By the use of antitoxins tetanus and diphtheria appear to be deprived of much of their terrible power. But it seems probable that a similar result may be obtained by the introduction of certain tissue juices into the general circulation. It was shown by Wooldridge that thyroid juice has a power of destroying anthrax poison, and it seems probable that increase of the circulation of certain organs will increase their tissue activity, will throw their juices or the products of their functional activity into the general circulation, and thus influence the invasion or progress of disease. As I have already mentioned, we are able to influence the circulation in muscles both by voluntary exertion and by passive massage, and we should expect that both of these measures would influence the constituents of the blood generally; and such, indeed, appears to be the case, for J. K. Mitchell[2] has found that after massage the number of blood corpuscles in the circulation is very considerably increased.

Had time allowed it, I had intended to discuss the modifications of the heart and vessels by the introduction of remedies into the circulation, the power of drugs to slow or strengthen, to quicken or weaken the power of the heart, to contract or relax the arterioles, to raise or lower the blood pressure, to relieve pain or to remove dropsy; but to do this would require time far exceeding that of a single lecture. Moreover, the methods and results were admirably expounded to the College by Dr. Leech in his Croonian lecture, and I have therefore thought I should be better fulfilling the wish of Harvey that the orator of the year should exhort the Fellows and Members of the College to search out the secrets of nature by way of experiment by directing their attention to fields of research which have received at present little attention, but promise results of great practical value. Lastly, I have to exhort you to continue in mutual love and affection among yourselves; and it seems to me that the best way of doing this is to direct your attention to the examples of Harvey and of our late President, whose death we deplore to-day. They were beloved by their fellows while they lived, their loss was lamented when they died, and they have left behind them an example not only of goodness, but of courage. Harvey, seated speechless in his chair, distributing rings and parting gifts to his friends while awaiting the approach of death; or Andrew Clark, steadfastly determining to continue at work and die in harness, in spite of the hæmoptysis which seemed to threaten a speedy death, afford us noble examples which ought to encourage us to follow the directions of the venerable Longfellow, who, taking the organ Harvey studied to symbolise such courage as Harvey and Clark showed, says—

> "Let us then be up and doing
> With a heart for any fate,
> Still achieving, still pursuing,
> Learn to labour and to wait."

[1] *Brit. Med. Journ.*, February 21, 1874, p. 221 *et seq.*
[2] *American Journal of Medical Science*, May 1894.

SCIENTIFIC METHOD IN BOARD SCHOOLS.[1]

AT the request of my friend and former pupil, Mr. W. M. Heller, I have undertaken to say a few words by way of introduction to the course which he is about to give here to assist a number of you who are teachers in schools in the Tower Hamlets and Hackney district under the School Board for London—a course of lessons expressly intended to direct your attention to the educational value of instruction given solely with the object of inculcating *scientific* habits of mind and *scientific* ways of working; and expressly and primarily intended to assist you in giving such teaching in your schools.

Nothing could afford me greater pleasure, as I regard the introduction of such teaching into schools generally—not Board Schools merely, but all schools—as of the utmost importance; indeed, I may say, as of national importance: and I now confidently look forward to the time, at no distant date, when this will be everywhere acknowledged and acted on. Personally I regard the work that I have been able to do in this direction as of far greater value than any purely scientific work that I have accomplished. At the very outset of my career as a teacher, I was led to see how illogical, unsatisfactory and artificial were the prevailing methods of teaching, and became interested in their improvement. My appointment as one of the first professors at the Finsbury Technical College forced me to pay particular attention to the subject and gave me abundant opportunity of practically working out a scheme of my own. I was the more anxious to do this, as I soon became convinced that if any real progress were to be made in our system of technical education, it was essential in the first place to introduce improved methods of teaching into schools generally, so that students of technical subjects might commence their studies properly prepared; and subsequent experience has only confirmed this view. Indeed it is beyond question, in the opinion of many, that what we at present most want in this country are proper systems of primary and secondary education: the latter especially. Now, most students at our technical colleges, in consequence of their defective school training, not only waste much of their time in learning elementary principles with which they should have been made familiar at school, and much of our time by obliging us to give elementary lessons, but what is far worse, they have acquired bad habits and convictions which are very difficult to eradicate; and their mental attitude towards their studies is usually a false one.

The first fruits of my experience were made public in 1884, at one of the Educational Conferences held at the Health Exhibition. On that occasion, and again at the British Association meeting at Aberdeen in 1885, in the course of my address as president of the Chemical Section, after somewhat sharply criticising the methods of teaching in vogue, I pointed out what I conceived to be the directions in which improvements should be effected. Others meanwhile were working in the

[1] A revised address delivered at the Berners Street Board School, Commercial Road, London, E., on October 9, 1894, by Prof. H. E. Armstrong, F.R.S.

same spirit, and consequently, in 1887, a number of us willingly consented to act as a committee "for the purpose of inquiring into and reporting upon the present methods of teaching chemistry." This committee was appointed at the meeting of the British Association in York, and consisted of Prof. W. R. Dunstan (secretary), Dr. J. H. Gladstone, Mr. A. G. Vernon Harcourt, Prof. H. McLeod, Prof. Meldola, Mr. Pattison Muir, Sir Henry E. Roscoe, Dr. W. J. Russell (chairman), Mr. W. A. Shenstone, Prof. Smithells, Mr. Stallard and myself. A report was presented at the Bath meeting in 1888, giving an account of replies received to a letter addressed to the head masters of schools in which elementary chemistry was taught. In 1889 and 1890 reports were presented in which were included suggestions drawn up by myself for a course of elementary instruction in physical science.

Let me at once emphasise the fact that these schemes were for a course of instruction in physical science—not in chemistry alone. The objects to be accomplished by the introduction of such lessons into schools have since been more fully dwelt on in a paper which I read at the College of Preceptors early in 1891, printed in the *Educational Times* in May of that year. After pointing out that literary and mathematical studies are not a sufficient preparation in the great majority of cases for the work of the world, as they develop introspective habits too exclusively, I then said, in future boys and girls generally must not be confined to desk studies; they must not only learn a good deal *about* things; they must also be taught how to *do* things, and to this end must learn how others before them have done things by actually repeating—not by merely reading about—what others have done. We ask, in fact, that the use of eyes and hands in unravelling the meaning of the wondrous changes which are going on around us in the world of nature shall be taught systematically in schools generally—that is to say, that the endeavour shall be made to inculcate the habits of observing accurately, of experimenting exactly, of observing and experimenting with a clearly defined and logical purpose, and of logical reasoning from observation and the results of experimental inquiry. Scientific habits and method must be universally taught. We ask to be at once admitted to equal rights with the *three R's*—it is no question of an alternative subject. This cannot be too clearly stated, and the battle must be fought out on this issue within the next few years.

Well, gentlemen and ladies, you have the honour of forming part of the advanced guard in the army which is fighting this battle—for the fight is begun in real earnest, although as yet on a small scale: nevertheless, in this case, the small beginning *must* have a great ending.

I had long sought for an opportunity of carrying the war into the camp of elementary education, and this came about four years ago when my friend Mr. Hugh Gordon was appointed one of the Science Demonstrators of the London School Board. During at least three years prior to his appointment, Mr. Gordon had been doing research work in the laboratory of which I have charge at the City and Guilds of London Institute Central Technical College, where he had also taken part in our elementary teaching, and he was already an ardent advocate of the educational policy of which I am so strong a supporter. Under the London School Board, he achieved a marvellous success, and the work that he has done as a pioneer cannot be too highly appreciated. He secured your confidence and sympathy, and interested his pupils; and working in a most unpromising field, under conditions of a most unsatisfactory and often depressing character, he has proved that to be possible, even easy (to the competent and willing teacher!), which my friends in higher grade schools have often scoffed at and declared to be impossible. In future, no public school will be able to excuse itself, except on the ground of want of will to give such teaching. I have often been told that our scheme was too costly, that much special provision must be made to carry it into effect, and that it requires so much time and such an increase in the teaching staff: my friend Gordon, with your assistance alone and no other addition to the staff, by successfully teaching, I believe, in seventeen of your schools, has given all these statements the lie. But I confess that as yet there are few who could accomplish so much; few equally well fitted and prepared for the work, so imbued with the right spirit, so convinced that the cause is a great and holy one, gifted with sufficient energy and enthusiasm to overcome the difficulties. The little book he has written, in which the first part of the course of teaching he adopted is broadly outlined,[1] although containing a few slight blemishes which mar its otherwise logical character—blemishes which will be very easily removed in a second edition—appears to me to be a most important contribution to educational literature, and will render great service to our cause. But I count as his greatest achievement the introduction of a proper balance—calculated to inspire confidence and respect—into the schools, for I believe the discipline of learning to weigh carefully and exactly to be of the very highest value to a child, and one of the most effective means of leading children to be careful and exact in their work generally. I envy my friend his success, as I have in vain tried to get proper balances introduced into schools of far higher grade in place of wretched contrivances costing but three or four shillings, *which can be of no service in forming character*, although I have no wish to deny that such may be made use of in illustrating principles.

Mr. Gordon, I believe, was appointed to teach mechanics under what I will venture to call an antiquated and wooden syllabus, but he had the courage to burst the bonds imposed upon him, and from the outset determined to teach what was likely to be of real service to his pupils. I have said that he gained the confidence and sympathy of the teachers with whom he was associated and whose work he was appointed to supervise and direct; but I believe that he did more, and achieved success in a task of greater difficulty—that he actually made converts of some of her Majesty's Inspectors whose sympathies had previously lain with literary studies.

I have thought it desirable thus to sketch the history of the introduction of our British Association scheme into School Board circles. Let me now further emphasise the importance of teaching *scientific method*, which after all is recognised by very few as yet. Let me endeavour to make it clear what I mean by scientific method. : that when I speak of scientific method, I do not mean a branch of science, but something much broader and more generally useful. We may teach scientific method without teaching any branch of science; and there are many ways in which we may teach it with materials always close to hand.

I have very little belief in the efficacy of lecturing, and it is always difficult to persuade those who are not already persuaded—I would therefore refer those of you who are not yet with me to a book from which they may derive much information and inspiration. I mean Herbert Spencer's "Essay on Education," the cheap edition of which, published by Williams and Norgate, costs only one shilling and elevenpence! It is a book which every parent of intelligence desiring to educate his children properly should read; certainly every teacher should have studied it thoroughly; and no one should be allowed to become a member of a School Board who on examination was found not to have mastered its contents. But as Herbert Spencer says—and the times are not greatly changed since he wrote—although a great majority of the adult males throughout the kingdom are found to show some interest in the breeding, rearing, or training of animals of one kind or other, it rarely happens that one hears anything said about the rearing of children. I believe the subject is seldom mentioned in School Board debates. Hence it happens that Herbert Spencer's book has had a smaller circulation than many novels, and that the 1893 edition is but the 34th instead of being the 340th thousand. After very fully discussing the question "What knowledge is of most worth?" he arrives at the conclusion that science is, and eloquently advocates the claims of the order of knowledge termed scientific. The following are eminently instructive passages in his essay:—"While every one is ready to endorse the abstract proposition that instruction fitting youths for the business of life is of high importance, or even to consider it of supreme importance; yet scarcely any inquire what instruction will so fit them. It is true that reading, writing, and arithmetic are taught with an intelligent appreciation of their uses. But when we have said this we have said nearly all. While the great bulk of what else is acquired has no bearing on the industrial activities, an immensity of information that has a direct bearing on the industrial activities is entirely passed over. For, leaving out only some very small classes, what are all men employed in? They are employed in the production, preparation and distribution of commodities. And on what does efficiency in the production, preparation, and distribution of commodities depend? It depends on the use of methods fitted to the respective natures of these commodities; it depends

[1] *Cf.* NATURE, 1893, xlix. 121.

on an adequate acquaintance with their physical, chemical, and vital properties, as the case may be: that is, it depends on science. This order of knowledge, which is in great part ignored in our school courses, is the order of knowledge underlying the right performance of those processes by which civilised life is made possible. Undeniable as is this truth, there seems to be no living consciousness of it: its very familiarity makes it unregarded. . . . That which our school courses leave almost entirely out, we thus find to be that which most nearly concerns the business of life. Our industries would cease, were it not for the information which men begin to acquire, as they best may, after their education is said to be finished. And were it not for the information, from age to age accumulated and spread by unofficial means, these industries would never have existed. Had there been no teaching but such as goes on in our public schools, England would now be what it was in feudal times. That increasing acquaintance with the laws of phenomena, which has through successive ages enabled us to subjugate nature to our needs, and in these days gives the common labourer comforts which a few centuries ago kings could not purchase, is scarcely in any degree owed to the appointed means of instructing our youth. The vital knowledge—that by which we have grown as a nation to what we are, and which now underlies our whole existence, is a knowledge that has got itself taught in nooks and corners; while the ordained agencies for teaching have been mumbling little else but dead formulas."

Some improvement there has been since Herbert Spencer wrote, but chiefly in technical teaching; and there is yet no national appreciation of what constitutes true education: fashion and vested interests still largely dominate educational policy.

Another advocate of the teaching of scientific method to whom I would refer you is Charles Kingsley, the celebrated divine, but also a born naturalist possessed of the keenest powers of observation, a novelist of the first rank, and a poet. Read his life, and you will find it full of inspiration and comfort. Study his scientific lectures and essays (vol. xix. of his "Collected Works," Macmillan and Co.), and you will not only learn why "science" is of use, but will have before you a valuable model of method and style. A friend—a member of the London County Council—to whom I happened to send some of my papers, noting my frequent references to Kingsley, remarked, "How very fond you are of his writings!" Indeed I am, for they seem to me to display a truer grasp of the importance of scientific method and of its essential character than do any other works with which I am acquainted. I recommend them because they are pleasant as well as profitable reading, and because our text-books generally are worthless for the purpose I have in view. Any ordinary person of intelligence can read Herbert Spencer's and Kingsley's essays and can appreciate them, especially Kingsley's insistent application of the scientific principle of always proceeding from the known to the unknown; but few can read a text-book of science—moreover, the probable effect of most of these would be to dissuade rather than persuade.

Kingsley's great point—and Herbert Spencer's also—is that what people want to learn is not so much what is, still less what has been, but how to *do*. And the object you must set before yourselves will be to turn out boys and girls who, in proportion to their natural gifts—for, as every one knows, you cannot make a silken purse from a sow's ear—have become inquiring, observant, reasoning beings, ever thoughtful and exact and painstaking and therefore trustworthy workers. To turn out such is the whole object of our scheme, which chiefly aims at the development of intelligence and the formation of character. In your schools information must be *gained*, not imparted. After describing how the intelligent mother trains her young child, Herbert Spencer remarks:—"To *tell* a child this and to *show* it the other, is not to teach it how to observe, but to make it a mere recipient of another's observations: a proceeding which weakens rather than strengthens its powers of self-instruction—which deprives it of the pleasures resulting from successful activity—which presents this all attractive knowledge under the aspect of formal tuition. . . " You must train the children under your care to help themselves in every possible way, and give up always feeding them with a spoon. Abolish learning lessons by rote as far as possible. Devote every moment you possibly can to practical work, and having stated a problem leave it to the children if possible to find a solution. Encourage inquisitiveness, but suggest methods by which they may answer their own questions by experiment or trial or by appeal to dictionaries or simple works of reference, part of the furniture of the schoolroom, and lead them to make use of the public library even: in after life you will not be at their elbows, but books will always be available, and if they once grow accustomed to treat these as friends to whom they can appeal for help, you will have done them infinite service and will undoubtedly infuse many with the desire to continue their studies after leaving school. Under our present system school books are cast aside with infinite relief at the earliest possible moment, and the desire for amusement alone remains. Teach history, geography and much besides from the daily papers, and so prepare them to read the papers with intelligence and interest, and to prefer them to penny dreadfuls and the miserable, often indecent, illustrated rubbish with which we are nowadays so terribly afflicted. At the same time, make it clear to them that the editorial "we" is but an "I," and that assertion does not constitute proof. If such be your teaching, and it have constant reference to things natural, you will also—as Herbert Spencer points out in a very remarkable passage—without fail be giving much *religious* culture, using the word in its highest acceptation, for, as he says, "it is the refusal to study the surrounding creation that is irreligious." As I have already said, one great—indeed the great—object of our teaching is the formation of character: and if you teach your pupils to be careful, exact and observant, and they become trustworthy workers, you are giving much training of the highest excellence; and if they have enjoyed such training, what does it matter what facts they know when they leave school?

But I hear you say that the inspectors will not allow all this. Gentlemen, do not fear the inspectors—they also are advancing; they also are learning that literary methods are insufficient, that desk studies must not absorb the entire attention of the scholars; that greater latitude must be permitted to the teachers, and especially in the direction of devising more suitable methods. And a new race of inspectors is coming into existence. Mr. Gordon, I know, had difficulties with the inspectors; but when they realised that he understood his business and learnt to appreciate his work, they soon became his supporters.

And with appreciative ministers like Mr. Acland at the head of affairs, we shall move far more quickly than heretofore, and shall be able soon to entirely throw off the cast-iron bonds of control by examination and payment on results—a refined method of torture affecting both teachers and taught most disastrously. We know that a holiday spent under healthy conditions at the seaside or in the country is of the greatest service. We are becoming accustomed to take care that our houses are properly ventilated and drained, and to rest satisfied that when this is the case their inhabitants may safely be left to themselves. In like manner, in future, we shall take care that our schools are fully provided with all necessary proper appliances—in which I include teachers—and we shall see that the teachers are working in accordance with a proper system; but we shall trouble ourselves little about the taught, feeling that if they have been placed under healthy conditions they cannot fail to have benefited, however little this may be apparent on the surface. In the days to come the work of the teachers will be directly criticised; they, not their pupils, will be examined: but always by competent and sympathetic inspectors who have become acquainted with the work and its difficulties practically, and are not mere theorists, whose main function will be that of guide, philosopher and friend—not that of inquisitor.

In the course that you are about to attend under Mr. Heller—the demonstrator upon whom has fallen the mantle previously worn by Mr. Gordon, and who is equally desirous of promoting and devising rational methods of teaching—you will in the first place devote your attention to exercises in measurement, including much that is ordinarily taught under mechanics and physics, the prime object of which is to teach accuracy of observation. You will then study a series of problems, mainly chemical, which have been arranged chiefly in order to cultivate reasoning powers and to teach the research method. In fact, what we want to do is, as far as possible, to put every scholar in the position of the discoverer. The world always has and ever will advance through discovery; discoveries, however, are rarely made accidentally—indeed we all pass from ignorance to knowledge by discovery, and by discovering how to do things that we have not done before we ever increase our powers of usefulness: we all require therefore to be taught how to discover, although we may never be called on to make original discoveries or have the opportunity. But as you proceed I trust that you will realise that the method which you are learning to apply is one which can be made use of in all your work—that the course has a broad educational value far transcending its special value as an introduction to physical science.

Lastly, I should like to take this opportunity of calling attention to the very great value to girls, as well as to boys, of teaching such as you are about to give. I fear that much that girls are being taught under the guise of domestic economy is of slight value educationally or otherwise, and that they are but having imparted to them little tit-bits of information which they are as likely as not to misapply. Nothing is done by way of increasing their intelligence and forming their characters. Lessons which would lead them to be observant, thoughtful and, above all, exact—lessons in method—would be of far higher and abiding value. They would then carry out their household functions with greater ease; there would be far less waste; less unhealthiness; far more comfort. I believe the need for such training to be indeed far greater in the case of girls than in that of boys. Boys are naturally apt in many ways, and even if neglected at school, perforce develop when they go out into the world; but girls are of a different disposition, and rarely seem to spontaneously acquire the mental habits which a training in scientific method can confer, the possession of which would be of inestimable value to them. Extraordinarily little has been done as yet on their behalf, and they have been cruelly sacrificed at examinations—for which, unfortunately, they appear themselves to have an insatiable natural appetite. It is to be hoped that the new Board will give the most serious attention to this matter, and that it will take steps to secure the teaching of scientific method in all the schools under its charge, whether boys' schools or girls' schools. Unhealthy buildings have attracted much attention; but the existence of a far more serious evil—the absence of healthy teaching suited to the times—has not even been noticed.

In these remarks, I have been able but briefly to bring before you a number of questions of importance—it must rest with you to seriously study the subject. It is a subject worth hard study, which will afford infinite opportunity and infinite satisfaction to the earnest worker.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The following examiners for the Natural Sciences Tripos were appointed on October 25. Physics: L. R. Wilberforce and Prof. G. F. Fitzgerald, F.R.S. Chemistry: W. J. Sell and Prof. W. Ramsay, F.R.S. Mineralogy: Prof. Lewis and H. A. Miers. Geology: P. Lake and Prof. G. A. J. Cole. Botany: Prof. F. W. Oliver, F.R.S., and W. Gardiner, F.R.S. Zoology: W. Bateson, F.R.S., and Prof. S. J. Hickson. Human Anatomy: Prof. A. Macalister, F.R.S., and Dr. H. D. Rolleston. Physiology: W. B. Hardy and Prof. E. A. Schäfer, F.R.S.

Prof. Bradbury delivered his inaugural lecture, as Downing Professor, on Wednesday, October 24, before a large audience. The subject was "Pharmacology and Therapeutics."

The University Lecturer in Geography, Mr. Yule Oldham, delivered a public lecture on the evening of October 24, on "A New Discovery of America." He will give during the present and the Lent terms a course on the "History of Geographical Discovery," on Thursdays at noon in the Chemical Theatre.

An election to the Royal Geographical Society's Studentship of £100 will be held in the Lent Term. The studentship is open to members of the University who have attended the lectures on Geography.

Of the Freshmen entered this term, 137 have announced their intention to study medicine at the University.

The period of five years for which Dr. Donald Macalister was elected as the University member of the General Medical Council expires on November 13. The Vice-Chancellor gives notice that an election will be held in the Senate House on Friday, November 9, from 2.30 to 3.0, at which all members of the Senate may vote. Dr. Macalister is eligible for re-appointment.

Dr. Charles Rieu, late keeper of the Oriental MSS. in the British Museum, has been elected Sir Thomas Adams Professor of Arabic in succession to Prof. Robertson Smith.

The Council of the Senate have issued a second report on special degrees (Litt.B. and Sc.B) for advanced study and research, in which they call attention to the steps in the same direction taken by the University of Oxford, the Scottish Universities, the Gresham (London) University Commissioners, and the University of Harvard. They propose that, as the bearings of the subject have greatly widened since their first report on post-graduate study, the whole question should be referred to a special Syndicate, with power to confer with other bodies and with the several teachers concerned.

We have received an advance copy of the report on the work of the Examinations Department of the City and Guilds of London Institute for the session 1893–94. During this session the number of classes registered by the Institute was 853, viz. 701 in Technology and 152 in Manual Training. The total number of students in attendance was 25,718, viz. 22,703 in technology and 3015 in manual training. At the examinations this year, 11,631 candidates presented themselves, being 1377 in excess of the number examined last year. The examiners for the Institute, like those of the Department of Science and Art, find that the Honours papers are the least satisfactory. It is pointed out that Honours students should be taught in special Honours classes. To quote the report:—

"It often happens that facilities for higher or advanced instruction are not provided at the schools, and that the candidates for Honours seeking further teaching are only able to attend the ordinary class a second session. This absence of higher instruction is a matter to be carefully considered by the Technical Instruction Committees of County Councils. Elementary technical instruction is of little value unless it encourages the student to seek further knowledge; and efforts should be made, even where the number of students is small, either to establish advanced classes, or to enable students to pursue their studies at other institutions where such advanced instruction may be obtained."

Mr. Herbert Tomlinson, F.R.S., has been appointed Principal of the South-West London Polytechnic Institute, now in course of erection in Chelsea. The institute, which will be of the same dimensions and be conducted on somewhat the same lines as the Battersea Polytechnic, will, it is hoped, be finished by April next.

It is announced that Dr. William Peterson, who for the last twelve years has been the Principal of University College, Dundee, has been appointed to the post of Principal of McGill University, Montreal, vacated by Sir William Dawson, F.R.S., more than a year ago.

SCIENTIFIC SERIALS.

American Journal of Science, October.—The standardisation of potassium permanganate in iron analysis, by Charlotte F. Roberts. A simple and rapid method for standardising a permanganate solution is to determine its strength, first, by comparison with electrolytic iron, and then by immediate titration with ferric chloride to determine the exact amount of iron in each cubic centimetre of the latter solution. This being ascertained, the ferric chloride solution can be employed at any time for the standardisation of potassium permanganate.—The detection and approximate estimation of minute quantities of arsenic in copper, by F. A. Gooch and H. P. Moseley. This is a modification of Sanger's process for wall-papers, whose application is rendered difficult by the fact that the presence of copper in the Marsh generator holds back the arsenic. The new process is based upon the simultaneous action of strong hydrochloric acid and potassium bromide upon the salt of arsenic.—Wave-lengths of electricity in iron wires, by C. E. St. John. A Lecher wire system was used in which the discs at the end towards the induction coil were left out, so as to obtain a form depending more directly upon the principle of electrical resonance. The indicator used was a bolometer as adapted by Rubens. It was found that the self-induction of iron circuits is greater than that of similar copper circuits under very rapid electric oscillations (115 million reversals per second). The difference in self-induction varies from 3·4 to 4·3 per cent., and increases with decreasing diameters. The increase in self-induction produces greater damping and a shortening of the wave-length of 1·5 to 2 per cent. The permeability of annealed iron wires under this rate of alternation is about 385. For oscillations of the same period, the wave-length along parallel copper wires varies directly with the diameter of the wires, the maximum difference observed being 5 per cent. with wires of 0·03915 and 0·1201 cm. diameter respectively.—The present status of high-temperature research, by Carl Barus. To clear away the anomalies now existing in high temperature data, either the boiling point of zinc must come down from 930° to 905°, or else the melting points of gold, silver, and copper must move up 30° or 40°, or both must move towards each other by corresponding amounts.—The recent eruption in the crater of Kilauea, by L. A. Thurston. This is a description of the subsidence of the lava lake on July 11, when its level fell 250 feet.—On solutions of metallic silver, by M. Carey Lea. The solutions previously described are all colloidal, and at the same time absolutely transparent.

Wiedemann's Annalen der Physik and Chemie, No. 10.—On pure water, by F. Kohlrausch and A. Heydweiler. (See Notes.)—Magnetic experimental investigations, by Carl Fromme. This paper deals with the self-induction and the electrostatic capacity of wire coils and their influence upon magnetic phenomena. Coils with bifilar winding are free from self-induction, and also from electrostatic capacity as long as their resistance does not exceed 1000 ohms. At 2000 ohms their capacity is already very considerable. Coils wound by Chaperon's method, *i.e.* with the direction of winding changing with each round, are perfectly free from capacity, and their self-induction is negligible. It is therefore quite feasible to determine their resistance by the alternate current method.—Examination of the Ketteler-Helmholtz dispersion formula, by Heinrich Rubens. The electromagnetic theory of dispersion, as developed by Herr von Helmholtz, is in complete accordance with the results obtained in the case of fluorspar, quartz, rock-salt, sylvine, and one of the heavy Jena silicate-flint glasses. The agreement extends over the whole region of the spectrum investigated, comprising 5½ octaves.—Bolometric investigations, by F. Paschen. This is a reply to Herr Ångström's criticism of his work on the absorption spectrum of carbonic anhydride.—On the infra-red dispersion of fluorspar, by F. Paschen. The spectrum of the fluorspar prism employed was calibrated by Langley's grating method. The best source of radiation was found to be a small piece of platinum foil coated with oxide of iron. The region of the spectrum examined extended from 0·8840 μ to 9·4291 μ, and the corresponding refractive indices ranged from 1·42996 to 1·31612.—Change of volume during melting, by Max Toepler. The author investigated the number of cubic cm. by which a gramme of various elements expanded or contracted during melting. The list included eleven metals and five non-metals. He found that the coefficient of expansion of the elements in the solid state, and their change of volume during melting, show a definite relation to each other.—The depression of the freezing-point of a solvent by electrolytes, by Harry C. Jones. In the case of a solution of phosphoric acid of concentrations 0·077 and 0·146, the numbers obtained, 2·52 and 2·31, are in fair accordance with those obtained by Arrhenius, but not with those of Loomis.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 3.—The Right Hon. Lord Walsingham, F.R.S., Vice-president, in the chair.—Mr. W. F. H. Blandford exhibited specimens of a sand-flea, chigoe or nigua, received from Mr. Szigetváry, of the Imperial Maritime Customs, China, who had found them in the ears of sewer-rats trapped at Ningpo. Mr. Blandford stated that the species was allied to, but not identical with, the American species, *Sarcopsylla penetrans*, L., one of the most troublesome pests in Tropical America and the West Indies to man and various domestic and wild animals, the female burrowing into the skin, usually of the feet, but also of any other accessible region. He said that the distribution of the chigoe was recorded over Tropical America and the Antilles from 30° north to 30° south, and of late years it had established itself in Angola, Loango, and the Congo. Colonel Swinhoe, Mr. McLachlan, Lord Walsingham, Mr. Champion, Mr. J. J. Walker, Mr. Barrett, and others, took part in the discussion which ensued.—Mr. F. C. Adams exhibited a specimen of *Mallota eristaloides*, a species of Diptera new to Britain, taken by himself in the New Forest on July 20 last. He said that the species had been identified by Mr. Austen, of the British Museum, and that he had presented the specimen to the National Collection. Mr. Verrall made some remarks on the species and on the distribution of several allied species in the United Kingdom. Lord Walsingham, as a trustee of the British Museum, expressed his satisfaction at the presentation of the specimen to that institution.—Mr. Tutt exhibited specimens of a form of *Zygæna exulans*, well scaled, and with the nervures and forelegs of a decidedly orange colour, collected during the last week in July by Dr. Chapman in the La Grave district of the Alps, at a considerable elevation; also specimens of the same species taken by Dr. Chapman near Cogne, and others from the Grison Valley, which were less well scaled. He also exhibited Scotch specimens for comparison, and stated that he was of opinion that the latter were probably as thickly scaled as the continental ones, but that, owing to the differences in the climate of Scotland and Switzerland, collectors had fewer opportunities of getting the Scotch specimens in good condition.—Mr. P. M. Bright exhibited a remarkable series of varieties of *Arctia menthastri* from N. Scotland, also series of *Liparis monacha* (including dark varieties) and *Boarmia roboraria* from the New Forest; *Zygæna exulans*, from Braemar; *Noctua glareosa*, from Montrose and the Shetlands; *Agrotis pyrophila*, from the Isle of Portland, and Pitcaple, N.B.; red varieties of *Teniocampa gracilis*; and a specimen of *Sterrha sacraria*, taken at light, at Mudeford, in October, 1893; also living larvæ of *Eulepia cribrum*.—Mr. J. J. Walker exhibited a living specimen of a large species of Pulex, which he believed to be *Hystricopsylla talpæ*, Curtis, taken at Hartlip, Kent. Mr. Verrall and the chairman made some remarks on this and allied species.—Mr. K. J. Morton communicated a paper, entitled "Palæarctic Nemouræ."—Lord Walsingham read a paper, entitled "A Catalogue of the Pterophoridæ, Tortricidæ, and Tineidæ of the Madeira Islands, with Notes and Descriptions of New Species." In this paper sixty-six species of Lepidoptera belonging to these families were recorded as occurring in the Madeiras, of which thirty were noticed as peculiar to the Islands, twelve as common to the Madeiras and Canaries, of which two were not known as occurring elsewhere, and one extends its range only to North Africa. Over thirty species were added to the list, and one new genus, seven new species, and two new varieties were described. Mr. Jacoby and Mr. Bethune-Baker made some remarks on the species and their geographical distribution.—Mr. Blandford read a paper, entitled "A Supplementary Note on the Scolytidæ of Japan, with a list of Species."

PARIS.

Academy of Sciences, October 15.—M. Lœwy in the chair.—The death of M. N. Pringsheim, on October 6, 1894, was announced to the Academy, and a short account of his work given by M. Bornet.—Determination, partly experimental and partly theoretical, of the inferior contraction of a bending fluid sheet, either depressed, submerged below, or adherent, on a weir having its up-river face vertical, by M. J. Boussinesq.—Observations of Gale's comet (1894, *b*) made with the great equatorial at Bordeaux Observatory by MM. G. Rayet, L. Picart, and F. Courty. A note by M. G. Rayet. The apparent positions of the comet on twenty-seven days between May 4 and July 31 are tabulated.—On the degree of incandescence of lamps, by M. A. Crova. The conclusions are given: (1) That the quantity of light emitted by a gas-burner per litre of gas used increases with the quantity of the combustible burnt per hour, whereas the degree of incandescence slightly diminishes, up to a maximum yield which should not be exceeded; (2) that, for lamps with incandescent substances, the maximum yield corresponds to the minimum amount of the combustible which must be burnt in order to obtain the maximum degree of incandescence.—Report on the memoir by M. Stieltjes, on "Researches on Continued Fractions." After a detailed consideration of the memoir, the report proceeds to say: "This work by M. Stieltjes is one of the most remarkable memoirs on analysis which has been written in late years."—Disappearance of the southern polar spot of Mars, by M. G. Bigourdan. The spot ceased to be visible on October 13.—First observations of the pendulum in the Alps of Dauphiny. The values obtained for the constant of gravitation are given below in column g_0, for comparison the values calculated for each place at latitude ϕ from the formula $g_c = 9{\cdot}78124 (1 + 0{\cdot}005243 \sin^2\phi)$ are appended. The values of g_0 are corrected to sea-level by means of the densities of subjacent formations taken from the most recent work.

	g_0.	g_1.
Paris	9·81013 ...	9·81030
Valence	9·80640 ...	9·80682
Grenoble...	9·80693 ...	9·80705
La Bérarde	9·80530 ...	9·80682
Marseilles	9·80539 ...	9·80536

The variation of the observed from the calculated value at La Bérarde becomes less when a correction is made for the influence of the mass of the surrounding mountains, g_0 is then 9·80575.—On the infinitesimal transformations of the trajectories of systems, by M. Paul Painlevé.—On the reduction of the structure of a group to its canonic form, by M. E. Cartan.—Experimental researches on the congelation of sulphuric acid of different degrees of concentration, by M. Raoul Pictet. Four extensive series of experiments carried out on large volumes of the acid, in different ways and with all the precautions indicated by the study of the laws of crystallisation at low temperatures, yield concurrent curves which include the cases between pure H_2O and pure H_2SO_4. This curve crosses the line of zero temperature five times (including origin with pure H_2O). On descending parts of the curve the liquid contains a larger proportion of acid than the solid, on ascending parts the inverse is the case; at the summits of the curve the titre of the liquid is the same as that of the solid. The maxima and minima do not, in general, correspond to definite hydrates.—Application of Trouton's law to the saturated alcohols of the fatty series, by M. W. Longuinine. The author finds that Trouton's constant is constant only for groups of similarly constituted substances, and varies from group to group. If M be the molecular weight, r the latent heat of vaporisation, T the absolute temperature of the boiling point, $\frac{Mr}{T} = 26 \cdot 34$ for fatty saturated alcohols. Water gives the value 25·86, ethers 21, hydrocarbons about 20. Formic and acetic acids appear to be exceptions giving the values 12·82 and 13·03. Acetic acid, however, gives 25·9 if the heat required to bring the vapour to the normal condition of $C_2H_4O_2$ be added to the latent heat. Probably formic acid is a similar case.—Action of chloride of sulphur on the copper derivatives of acetylacetone and benzoylacetone, by M. Victor Vaillant.—On estimations of glucose by cupro-alkaline liquids, by M. Fernand Gand.—On pine tar, by M. Adolphe Renard. A new hydrocarbon $C_{14}H_{22}$ is characterised; it is probably a member of the aromatic series.—Action of the sands and waters of the Sahara on cements and hydraulic limes, by M. Jules Perret.—On the homarian origin of crabs, by M. E. L. Bouvier.—On a disease of Ailanthus in the parks and promenades of Paris, by M. Louis Mangin. This disease is characterised as fungoidal, but the species of fungus causing it has not yet been determined.

NEW SOUTH WALES.

Linnean Society, August 29.—Prof. David, President, in the chair.—On the Kuditcha shoes of Central Australia, by R. Etheridge, jun. The remarkable slippers described are in vogue among certain tribes toward the centre of the continent. They are made of human hair, interlaced with emu feathers, with a cementing medium of human blood in the sole. Their variously described functions—their use by the rain-maker, by the authorised agents in obtaining blood-revenge, and to disguise tracks when wife-hunting—were summarised and discussed; and it was pointed out that it is not improbable that their use was not so much to conceal tracks as to disguise the direction in which the wearer was travelling, the heel and toe being alike.—A list of exotic trees and shrubs which have become hosts for certain Australian parasitical plants, by Fred Turner. Indigenous members of the N.O. *Loranthaceæ*, more particularly *Loranthus celastroides*, Sieb., *L. pendulus*, Sieb., and *Viscum articulatum*, Burm., were shown to have taken very kindly to certain exotic plants. Twenty-seven species, belonging to a dozen natural orders, serving as hosts, had come under the author's notice in New South Wales, the *Rosaceæ*, as compared with other orders, supplying the largest number.—On the formation of a "Mackerel Sky," by A. H. S. Lucas. A description of the remarkable sky of this nature seen over Sydney on April 20, 1894, was given from the notes of Mr. Russell, the Government Astronomer. The author then proceeded to compare the arrangement of the clouds with that of the ridges of sand in ripple-mark, and showed how they are formed similarly, as a result of the wave-motion of layers of the air. He considered the condensation to be produced by rarefaction of the air in the ridges of the waves with consequent fall of temperature. The condensation into cloud thus rendered manifest the position of the wave-crests. He then referred to Prof. von Bezold's paper in the February number of "Himmel und Erde," which advances somewhat similar views as to the origin and importance of wave-clouds. He concluded by suggesting that the wave-cloud, or *Undulus*, should take its place in the classification of clouds by the side of the other elemental forms, *Cirrus*, *Cumulus* and *Stratus*.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Dissections Illustrated: C. G Brodie. Part 3 (Whittaker).—Lectures on Biology: Dr. R. W Shufeldt (Chicago).—Chemical Handicraft (J. J. Griffin).—From the Greeks to Darwin: Dr. H. F. Osborn (Macmillan).—On Preservation of Health in India: Sir J. Fayrer (Macmillan).—Manual of Physico-Chemical Measurements: Prof. W. Ostwald, translated by Dr. J. Walker (Macmillan).—Text-Book of the Diseases of Trees: Prof. R. Hartig, translated by Dr. W. Somerville (Macmillan).—University College, Nottingham, Calendar 1894-95 (Nottingham, Sands).—Reprint of the North American Zoology: George Ord, Appendix by S. N. Rhoads (the Editor, Haddonfield, N.J.)—Peru, 2 Vols: E. W. Middendorf (Berlin, Oppenheim).—A Manual of Exotic Ferns and Selaginella: E. Sandford; cheaper edition (Stock).—University College of North Wales, Calendar 1894-95 (Manchester, Cornish).—Leçons de Chemie: H. Gautier and G. Charpy; deux edition (Paris, Gauthier-Villars).—The Great Ice-Age: Dr. James Geikie, 3rd edit. (Stanford).—Electric Light and Power: A. F. Guy (Biggs).

PAMPHLETS.—A Laboratory Guide and Analytical Tables: J. Grant (Manchester, Smith and Wood).—A Discourse on Roses and the Odour of Rose: J. C. Sawer (Brighton, Smith).—Report on Meteorological Observations in British East Africa for 1893: E. G. Ravenstein (Philip).—Brief Notes on the Physical and Chemical Properties of Soils: R. Warington (Chapman).—On the Whirling and Vibration of Shafts (Philosophical Transactions of the Royal Society of London, Vol. 185 (1894) A, pp. 279-360: S. Dunkerley (K. Paul).—On Derived Crystals in the Basaltic Andesite of Glasdrumman Port, co. Down (Scientific Transactions of the Royal Dublin Society, Vol. v. series 2: Prof. G. A. J. Cole (Williams and Norgate).—Twelfth Annual Report of the Fishery Board for Scotland for the Year 1893, Part 2.—Report on Salmon Fisheries (Edinburgh).—The Slide Rule: C. N. Pickworth (Emmott).—Geschichte der Bibliothek und Naturaliensammlung der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher: Dr. O. Grulich (Halle).

SERIALS.—Encyklopædie der Naturwissenschaften, Dritte Abthg., 22 and 23 Lief[g], Zweite Abthg., 83-85 Lief[g], (Breslau, Trewendt).—Engineering Magazine, October (Tucker).—American Journal of Science, October (New Haven).—Record of Technical and Secondary Education, October (Macmillan).—American Meteorological Journal, October (Ginn).—Proceedings of Bristol Naturalists' Society, 1893-94 (Bristol).—American Historical Register, No. 2 (Philadelphia).—Palestine Exploration Fund, Quarterly Statement, October (London).—Quarterly Review, October (Murray).

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