THURSDAY, OCTOBER 4, 1894.

ANOTHER SUBSTITUTE FOR DARWINISM.

Nature's Method in the Evolution of Life. (London: T. Fisher Unwin, 1894.)

ALMOST every educated man who can write good English, but who cannot understand Darwin's theory of Natural Selection, seems to feel compelled to explain his difficulties and to offer his own preferable theory in the form of a volume on Evolution. We are thankful that the present anonymous volume is a small one; but that is its chief, if not its only merit. The writer has not, in the first place, made any serious attempt to understand the theory he objects to as inadequate; and, in the second place, his own theory is so vague and so entirely unsupported by either fact or argument as to be altogether worthless. A few extracts from the book will serve to support both these statements.

In the first chapters discussing the Darwinian theory we have this statement:—

"Deviations, although minute, tend, it is alleged, to accumulate, and the accumulations over prolonged periods of time ultimately produce variations from the original type, sufficient to constitute new species." (p. 10.)

Of course no such "tendency" was ever alleged by Darwin. The difference in size between the Shetland pony and the dray-horse is said to be due to difference of climate and food—

"There is no reason to doubt that the size of the former is due to an unfavourable climate and insufficient quantity and quality of food, and that of the latter to comfort combined with a generous diet."

But he ignores the case of the lap-dog and Italian greyhound on the one hand, and the Dingo or Esquimaux dog on the other, where the same contrasted conditions have apparently acted in a manner precisely opposite. Again, he seems to think that the struggle for existence is only the struggle for food, and that such a struggle must cause deterioration. He supposes the case of rabbits on a small island, and says—

"The rabbits possessing the strongest vitality and able to live on the smallest quantity of food, will have proved themselves the fittest. . . . But have the rabbits of the highest type come through the struggle unscathed? Have the fittest of the survivors become fitter to continue the conflict than the rabbits that were fittest when the conflict began? If so, it would follow that scarcity of food is more favourable to animal life than abundance." (p. 28.)

Here he clearly falls into confusion through some idea of abstract "fitness"—fitness independent of the conditions of existence, as shown by his statement on the next page that the struggle for existence "is evidently inimical to beneficial variation." Again (p. 31) he asks: "Is there any ground for believing that excessive use develops beneficial variation?" showing that he entirely misunderstands the theory of the natural selection of individual variations.

This misconception is further shown by quoting the inability of the ostrich to fly as an example of "the failure of natural selection"; and as a still more glaring example of this failure he refers to the curious Chaparral Cock of California, a ground cuckoo which lives in the open woodlands, runs very quickly, but rarely flies. The alleged "failure" is supposed to exist because the mounted cowboys catch the bird with their whips, and it does not escape by flying! It never seems to have occurred to this writer that both these birds are striking examples of the success of natural selection, since they have both become well adapted to a terrestrial life, as shown by their abundance in individuals. The notion seems to be that every bird which cannot fly as well as a swallow or a falcon must be a failure. Yet on the author's own theory, which, as we shall see, is a modified form of special creation, the failure, if it existed, would be even more deplorable.

This theory, which he calls "Nature's Law of Selection," is thus defined—

"What, for want of a better term, we call the progress of species, is not evolving a new organism out of one previously existing, but by substituting another more closely adapted to the conditions." (p. 62.)

How this other one is substituted is a mystery which is but imperfectly explained further on, in a chapter on "The Method of Evolution," in which we are told that—

"Every organism is the product of a particular combination of force acting on matter according to certain fixed laws, and that the same combination of force, united with matter, has a constant and persistent individuality, which is reproductive."

And this enigmatical proposition is supposed to be made clearer by the next sentence.

"As there are elemental substances, so there may be elemental forces possessing special qualities and affinities, which may have, from time to time, as conditions became favourable, combined with each other to work out evolution." (p. 67.)

If the former statement was obscure, this latter statement, of what "may be" and "may have," renders that obscurity perceptibly greater. Then follow several pages about the Power Loom as compared with the Loom of Life, after which we have a further statement of how the different life forces have acted successively on the simple cell "embodying the first vital force," and thus developed the various organisms. (p. 71.) In order to give us a concrete example of the theory at work, we have this account of the origin of the whale, and the author may well be complimented on his courage in attacking so difficult a problem which almost brought Darwin himself to grief. But a greater than Darwin is here. Read and wonder.

"According to our theory, the life force of the whale proceeds to fashion its skeleton on the type of its terrestrial antecessor, and builds the structure to the junction of the antecedent form with the new, and somewhat beyond the first point of differentiation between them. The bones of the hind limbs begin to be formed, but forthwith the new force special to the whale, coming into play, supersedes the forces that would have completed the antecedent type, and the whale is produced."

That is how it was done! For brilliancy of invention and clearness of exposition this is only comparable with that fascinating account, by Adrianus Tollius, of the origin of stone implements by natural causes, as quoted by Mr. Tylor.

"He gives drawings of some ordinary stone axes and hammers, and tells how the naturalists say that they are generated in the sky by a fulgureous exhalation conglobed in a cloud by the circumfixed humour, and are as it were baked hard by intense heat, and the weapon becomes pointed by the damp mixed with it flying from the dry part, and leaving the other end denser, but the exhalations press it so hard that it breaks out through the cloud, and makes thunder and lightning. But, he says, if this be really the way in which they are generated, it is odd that they are not round, and that they have holes through them, and those holes not equal through, but widest at the ends. It is hardly to be believed he thinks."[1]

Here we have an example of a brilliant and comprehensive theory—a theory able to explain everything, yet subject to petty criticism! And we fear that our anonymous author's equally brilliant theory of the orgin of the whale will be not less unfortunate. Of course we are assured that the theory explains almost everything—homology, embryology, rudimentary organs, &c., though he does, modestly, admit that it does *not* explain why hybrids are sterile. In order not to misrepresent the writer one more passage must be quoted, because he there brings his ideas more nearly into accord with that theory of discontinuous variation which has been recently put forward.

"Evolution proceeded by successive distinct gradations or stages. The differentiation of every new species resulted from forces *ab extra* superimposed on, and, to some extent, superseding or modifying the forces that produced the species or genus immediately preceding in the same line of development. The fecundated ovum of a species was, as it were, fecundated a second time with a new force, and the ovum thus bi-fecundated produced, instead of the species to which it belonged, a new species built upon a modification of its predecessor."

The theory is therefore one of special creation through the ordinary process of descent. The "new forces *ab extra*" which produced a whale from a terrestrial animal were also at work every time one species of tit, or warbler, or beetle, or snail, was modified in adaptation to a slightly different mode of life, and became a new species. Thus all is explained; except why there is any variation of these specially adapted species, why they increase at such an enormous rate necessitating such wholesale destruction, why there is any struggle for existence. All these phenomena, which are the very essence of a theory of descent with modification by natural selection, are entirely out of place in a theory of special creation, and are therefore the condemnation of any such theories. ALFRED R. WALLACE.

1 "Early History of Mankind," second edition, p. 227.

THE MEAN DENSITY OF THE EARTH.

The Mean Density of the Earth. An Essay to which the Adams Prize was adjudged in 1893 *in the University of Cambridge*. By J. H. Poynting, Sc.D., F.R.S. (London: C. Griffin and Co., Limited, 1894.)

THIS essay, which contains an account of Prof. Poynting's well-known investigation of the mean density of the earth, though the last Adams prize essay, is the first to which that prize has been awarded for experimental work. We hope that it is the first of a long series of essays in which the candidates will attack the questions proposed by experiment as well as by mathematical analysis. We can hardly expect, however, that the level reached by the magnificent experimental work of Prof. Poynting will always be maintained.

The essay consists of two parts, the first containing an account of previous determinations of the mean density, the second an account of Prof. Poynting's own determination by means of the ordinary balance.

The first part begins with an account of the astronomical or geodetical methods, in which the attraction of a mountain was compared with that of the earth, as in the experiments of Bouguer in Peru, of Maskelyne and Hutton on Schehallien, of James and Clark on Andrews Seat, of Carlini on Mount Cenis, and of Mendenhall on Fujiyama; or with that of the slab of matter above the surface of a mine as in Airy's Harton Pit experiments, and von Sterneck's experiments in Pribram and Freiberg The beautiful method employed by von Sterneck in his pendulum experiments ought to be more widely known in England. The object of the astronomical method has undergone a curious reversal. It was originally to deduce the mass of the earth from a supposed knowledge of the distribution of matter in the locality of the experiment, whereas now it is rather to find the distribution of matter in this locality, assuming the mass of the earth to be known.

The other methods are laboratory methods, and depend upon the measurement of the attraction between known masses. Prof. Poynting points out a very interesting under-estimate of this attraction made by Newton. In the Principia, Newton estimated that two spheres of the density of the earth, each a foot in diameter, would, if separated by quarter of an inch and left to their own attractions, take nearly a month to come into contact. Prof. Poynting shows that there is a mistake in the arithmetic, and that in reality the spheres would come into contact in between five and six minutes.

It is now very nearly a century since the first measurements of the attraction between two masses in a laboratory were published by Cavendish ("Experiments to Determine the Density of the Earth," *Phil. Trans.* 1798), who used the torsion balance. Since then this method has been used by Reich, Baily, Cornu and Baille, and Boys; while the ordinary balance has been used by von Jolly, Prof. Poynting himself, and by König, Richarz and Krigar Menzel, working in collaboration, while the method of the pendulum balance has been used by Wilsing. The labour expended over these investigations may be estimated from the fact that, to take only two modern instances, Prof. Poynting's experiments extended over twelve years, while those of Cornu and Baille were commenced in 1870, and are not yet completed. The essay contains a clear and critical account of the preceding experiments. The result of the criticism is to raise, if possible, Cavendish's fame as an experimenter. Of Baily's laborious research, Prof. Poynting says: "The critical examination it has received in later years has entirely destroyed any confidence in the result. It remains, however, as a most remarkable and useful example of the danger of substituting multiplication of observations for consistency." The contrast between the amount of work which has been published on the numerical magnitude of the attraction, with that which has appeared on the effects, if any, which modifications of the surroundings exert on this attraction is very remarkable. Newton's hollow pendulum experiments, repeated with greater accuracy by Bessel, seem to be almost the only investigations which have been published on what may be called the physical properties of gravitational attraction. As far as we know, the attraction between two given masses depends merely upon their geometrical configuration; it is independent of the medium between them, of the physical state of the masses, whether they are solid, liquid or gaseous, amorphous or crystalline; it does not depend upon the temperature of the masses. Indirect evidence, often derived from the Cavendish experiments, shows that the preceding statements must at least be very approximately true. Again, chemical analysis is founded on the hypothesis that the weight of an atom of a chemical element is unaltered whatever chemical combinations it may form, or whatever the temperature to which it may be raised. It is, however, often difficult to tell the degree of approximation to the truth of the preceding statements which is indicated by such indirect evidence, and a direct experimental investigation to determine an inferior limit to the accuracy of some of the preceding statements would not be superfluous. Take the case, for example, of the statement that the weight of an atom cannot be altered by chemical combination: it would be for the advantage of science if this were proved with the utmost possible accuracy attainable by present methods for some definite chemical combinations. The question is of interest in connection with the view that the atoms of elements are aggregations of atoms of some primordial substance not very much lighter than hydrogen. The values of the atomic weights of the elements is inconsistent with this view if each atom of the primordial element retains its weight unaltered in the complex atom. If, however, it suffers a slight change of weight, then we might expect to find traces, though perhaps faint ones, of such a change in ordinary chemical combinations.

Another question which has excited some interest is a possible connection between the magnitude of gravitational attraction and temperature. Prof. Hicks has pointed out that Baily's results gave a value for the mean density of the earth which uniformly diminished as the temperature increased, indicating, if the effect is a real one, that the attraction between two masses increases with the temperature, and von Sterneck, in his experiments at Freiberg, found a remarkable relation between the temperature and the value of gravity. Prof. Poynting discusses these and other results, and comes to the conclusion that they are to be explained by other causes, and do not afford any evidence at all that the attraction between bodies varies with the temperature. The point is one which has a direct bearing on Prof. Poynting's own experiments, as the final value for the mean density is got by taking the mean of two sets of experiments, and as the temperature in the two sets differed by about 3·5° C., an uncorrected temperature effect would affect the result.

We are very glad to find from this essay that Prof. Poynting is engaged on an investigation as to whether the attraction between two crystals depends on the relative position of their axes.

The second part of the essay consists of Prof. Poynting's paper "On a Determination of the Mean Density of the Earth," published in the *Phil. Trans.* for 1891. This, in addition to the actual determination of the mean density, is almost a treatise on the method of using a balance so as to get great sensitiveness. The work is a model of patient care and skill, as well as of clearness of exposition, and we feel as we read it that the utmost has been made out of the apparatus and the method. Prof. Poynting is of opinion that it is only air-currents which prevent the balance being used with an accuracy far beyond anything hitherto approached; the ordinary balance is more sensitive than the torsion balance to air-currents, since these produce the greatest disturbance in the vertical direction, which is the direction of displacement in the ordinary balance. Prof. Boys has shown that to minimise the effect of air-currents the size of the apparatus ought to be reduced as much as possible. Prof. Poynting says that if he were designing his apparatus again, instead of using, as he did, an exceptionally large balance, he would go to the opposite extreme and use a very small one.

Of all the methods hitherto used to determine the mean density of the earth, the arrangement used by Prof. Boys seems to be the one capable of the greatest accuracy. There are, however, certain points about the method of the common balance, such as the simplicity of the most important measurements, and the absence of the necessity to determine a time of swing with great accuracy, which make it worthy of such a work as Prof. Poynting has devoted to it.

The mean density of the earth found by Prof. Poynting is 5·49. Prof. Boys' result is 5·53.

MINING.

A Text-book of Ore and Stone Mining. By C. Le Neve Foster, B.A., D.Sc., F.R.S. 8vo. Pp. 744, with Frontispiece and 716 Illustrations. (London: C. Griffin and Co., Limited, 1894.)

IN view of the paramount importance of the production of minerals to Great Britain, and of the constant enterprises for working gold ores and other minerals in most of our colonies, it is certainly remarkable that there has hitherto been no satisfactory systematic treatise on metalliferous mining available. It is a matter of congratulation, therefore, that so eminent an authority as Dr. Le Neve Foster has found time, with his many duties as H.M. Inspector of Metalliferous Mines, and as Professor of Mining at the Royal College of Science and Royal School of Mines, to fill up so important a gap in technical literature. His compendious volume will undoubtedly be warmly welcomed as an invaluable work of reference, not only by mining students, but by all English-speaking mining engineers. The subject is so extensive, that the author's task of keeping his text-book within moderate limits, without erring on the side of omission, was one of considerable difficulty. He has, however, been thoroughly successful; and the extremely methodical arrangement of the material obviates, as i did in the case of Rankine's engineering treatises, the possibility of the work becoming rapidly obsolete.

The subject has been divided into the following chapters : (1) Occurrence or manner in which the useful minerals are found in the earth's crust ; (2) prospecting or search for minerals ; (3) boring ; (4) excavation ; (5) supporting excavations ; (6) exploitation or working away of minerals ; (7) haulage or transport along roads ; (8) winding or hoisting in shafts ; (9) drainage ; (10) ventilation ; (11) lighting ; (12) descent and ascent ; (13) dressing ; (14) principles of employment ; (15) legislation ; (16) condition of workmen ; and (17) accidents. The mining of coal is not dealt with ; a special treatise having been published, as a companion volume, by Mr. H. W. Hughes.

In the first chapter, the time-honoured definition of mineral veins as the contents of fissures is wisely expanded by the author. Veins, he states, are tabular mineral deposits formed since the enclosing rocks, and either occupying cavities formed originally by fissures, or consisting of rock altered in the vicinity of fissures. There can be no doubt that many so-called fissure-veins are really substitutional deposits, and the necessity for some change in the definition is apparent. The author enters a timely protest against the use of the word "gangue" for the veinstone, lode-stuff, or matrix. Mistranslated from the German *Gang* (vein) into French, and thence into English, it has lost its original meaning, and should be consigned to oblivion.

The fascinating but perplexing subject of the formation of mineral veins is clearly and concisely dealt with. Sandberger's lateral secretion theory, assuming that the minerals were leached out of the adjacent rocks and re-deposited in the vein cavity, is regarded by the author as not entirely proven. This view, it is interesting to note, is shared by Posepny, who in a paper read, last year, at the Chicago Congress, published since the appearance of Dr. Le Neve Foster's treatise, expresses the opinion that Sandberger's theory suffers from several fundamental defects, and by being accepted as a simple and welcome explanation of the genesis of ore-deposits, has hindered the progress of knowledge.

In studying the mode of occurrence of minerals, abstract definitions are not sufficient. The student must see how they can be applied in practice. The author, therefore, gives a carefully chosen series of examples of the modes of occurrence of the more important minerals arranged in alphabetical order. The thoroughness with which he deals with this section is evident from the fact that he gives accounts of the occurrence of carbonic acid, of petroleum, and of ice. Liquefied carbonic acid is now a regular article of commerce in Germany, whilst the American ice trade affords employment to 12,000 men, 1000 horses, and 100 steam engines. Full descriptions of the mining of ice, to which the author might usefully have given references, have been published in Helland's Norwegian treatise on mining, and in a paper read in 1883, by Mr. W. P. Blake, before the American Institute of Mining Engineers.

The eleven chapters dealing with mining proper cover some 450 pages, and include descriptions and illustrations of all the important appliances used in mining work, including the most recent inventions. Indeed, if fault can be found with this section, it is that the author devotes too much space to inventions so recent that their advantages have not been thoroughly tested. The description of the Franke drill, for example, the smallest and lightest boring machine in practical use, introduced last year at the Mansfeld copper mines, occupies more space than that of the modern stamp battery.

The chapter on dressing, under which term the author includes the processes by which the miner prepares his product for sale, or by which he extracts a marketable product from it, covers 100 pages, and is of special interest. Bearing in mind the needs of teachers, the author supplies useful information enabling the student to construct ingenious models of glass-tubing, &c., to illustrate the principles of motion in water and in air, and the construction of dressing appliances. A mixture of like-sized grains of coal, calcspar and galena, minerals of distinctly different colour and specific gravity, is used in these experiments.

The author's classification of the dressing processes employed is quite novel. There are three main divisions, according as the process is effected solely by mechanical means, or is based upon the physical or chemical properties of the minerals treated. The main divisions are subdivided in the following manner :—

I. *Mechanical processes.*—(1) Washing in order to separate clay, mud, and sand ; (2) hand-picking ; (3) breaking-up, subdivision, or shaping ; (4) agglomeration or consolidation ; (5) screening or sifting—that is, classification according to size.

II. *Processes depending upon physical properties.*—(1) Motion in water ; (2) motion in air ; (3) desiccation ; (4) liquefaction and distillation ; (5) magnetic attraction ; (6) separation according to degree of friability.

III. *Processes depending upon chemical properties.*—(1) Solution, evaporation, and crystallisation ; (2) atmospheric weathering ; (3) calcination ; (4) cementation or precipitation by iron ; (5) amalgamation.

This classification cannot fail to be of the utmost value to the student, even if the subdivisions are not strictly defined in reality. A carefully considered classification of this character converts dressing into a rational science, instead of leaving it, as is the case in the existing treatises on the subject, an unsystematic collection of heterogeneous facts. One cannot but regret that the exigencies of space have compelled the author to give but meagre information regarding some of the most important mechanical appliances. Dressing is, however, a special subject of sufficient importance to command a literature of its own, and it is to be hoped that the author may some day be induced to expand his classification into a complete treatise.

The 711 illustrations given by the author are clear and effective ; and in all important cases the scale is indicated. The frontispiece, representing an overhand stope at the 274-fathom level at Carn Brea Mine, Cornwall, from a photograph by Mr. J. C. Burrow, is a most artistic piece of work and a triumph in underground photography. With his characteristic minute accuracy in detail and in nomenclature, the author has introduced the expression "274-fathoms level" in place of the usual "274-fathom level." No doubt he can bring forward arguments in favour of this practice, which he adopts throughout the book; but to Cornish ears it will sound as oddly as if he alluded to a 2-feet rule, or to a 2-years old colt, or as if he spoke of a Guardsman as a "six-feeter."

A very full and accurate index greatly adds to the value of the work. The insertion of the names of von Cotta, von Groddeck, and von Sandberger under the letter V is, however, open to objection.

Prof. Le Neve Foster is to be congratulated on having enriched our technical literature with a contribution of substantial value. Undoubtedly the best book on the subject in the English language, it bears comparison with the treatises of Callon and Haton de la Goupillière in French, and with those of Serlo and Koehler in German. It should find a place in every mine office, and, by being carefully studied by mine managers, should help to raise the British ore and stone mining industries from their present depressed condition.

BENNETT H. BROUGH.

DR. ADLER'S OBSERVATIONS ON GALL-FLIES.

Alternating Generations: a Biological Study of Oak Galls and Gall Flies. By Hermann Adler, M.D., Schleswig. Translated and edited by Charles R. Straton, F.R.C.S., Ed., F.E.S. With illustrations. (Oxford: Clarendon Press, 1894.)

THE order *Hymenoptera* has never been a popular study, in the sense in which the *Coleoptera* and *Lepidoptera* have become so during the last century, but it probably numbers among its votaries nearly three times as many students as any of the remaining orders. Nor is this surprising, for although it cannot compete with the *Lepidoptera* in beauty of colouring, it surpasses the *Coleoptera* in its variety of form, and is probably more numerous in species than any other order. It supplies us with some of the most valuable products which are yielded by insects, such as honey and ink, and stands at the head of the insect world, both in intelligence and in diversity of habits.

The *Aculeata*, or ants, bees, and wasps, and, after these, the *Tenthredinidæ*, or saw-flies, have generally received most attention from those entomologists who have specially devoted themselves to the study of the *Hymenopteræ*. But within the last twenty or thirty years, several entomologists have occupied themselves with the study of the *Cynipidæ*, or Gall Flies, and have discovered a system of alternate generations in these insects almost as remarkable as that which had previously been observed in the *Aphididæ*, or Plant-lice, which belong to the very different sub-order *Homoptera*.

One of the most important contributions to this subject was Dr. Adler's treatise, "Über den Generationswechsel des Eichen-Gallwespen," which was published in the *Zeitschrift für wissenschaftliche Zoologie* for 1881 (vol. xxxv.), with three coloured plates; and it is this work which Dr. Straton has now brought within the reach of every English entomologist.

As a rule, works on many branches of science become obsolete shortly after publication, and are seldom required except by specialists; but this does not apply to observations on transformations and habits. Men who have sufficient patience, taste and opportunity to make such observations of real value are few and far between, and their results, if sufficiently accurate, remain of permanent value, however much they may be enlarged by future observations. Hence Dr. Straton has rendered a real service to science by publishing an English edition of a work of this description, which was originally issued several years ago in a costly periodical, which would hardly be accessible, even to those who can read the original, except [in metropolitan or university libraries. Dr. Adler's work has been carefully and accurately translated, including his descriptions of the insects observed, his table of alternating generations, and his observations on gall-formation, oviposition, &c.; and the coloured plates have been faithfully reproduced, though the original stones had been destroyed.

Dr. Straton has added an introduction, a chapter on *Cynips Kollari*, synoptical tables of galls, a classification of the *Cynipidæ*, and a bibliography and index. The introduction deals with the history of the study of galls, and the questions of parthenogenesis, alternating generations, &c., in arthropods, and more especially in the *Cynipidæ*, the changes in the ovum and sperm-cells being described in detail, with reference to the views of Weismann and others; and Dr. Straton's own remarks will be found interesting to embryologists in general. Incidental remarks on gall parasites, and other points unconnected with the main subject of the book, are occasionally introduced.

We have only to regret that it has not occurred to Dr. Straton to add the principal bibliographical references to descriptions, &c., of each species, and a note as to whether it is common or rare in England. These additions, which might have been placed between brackets, to distinguish them from Dr. Adler's work, would have added to the usefulness of the book, which may probably penetrate to country places where the information which it contains cannot be supplemented by reference to larger works; to which, however, it is very necessary to refer the student, that he may know what to consult if he wishes to pursue the subject further. This want is only imperfectly supplied by a bibliography, absolutely necessary as this is for advanced students, and also to indicate the extent of an author's reading, and the sources from whence he has derived his information.

W. F. K.

OUR BOOK SHELF.

Hygiene. By J. Lane Notter, M.A., M.D., and R. H. Firth, F.R.C.S. Pp. 374. (London: Longmans, Green, and Co., 1894.)

Primer of Hygiene. By Ernest S. Reynolds, M.D. Pp. 158. (London: Macmillan and Co., 1894.)

THOUGH it is not expressly stated that Dr. Notter's book "has been designed to meet the requirements of the syllabus of the Science and Art Department," the work is issued in the series of manuals published by Messrs. Longmans for students working up for South Kensington examinations, from which fact it may be inferred that such students will use it as a text-book. And as the author is an examiner in hygiene under the Department of Science and Art, his book doubtless contains the kind of knowledge that commands marks. Therefore teachers would do well to adopt it for their classes; and all writers of other text-books covering the same ground may regard their works as doomed to rapid extinction. Whether an examiner should prepare a text-book for his own syllabus is a matter of opinion, and much can be said both for and against the system. But, however that may be, it is certain that persons desirous of passing an examination could not do better than read the works of the one who sets the questions. In the case of the book before us, we have no hesitation in saying that it is as clear and connected an exposition of the laws of health and causes of disease as anyone could desire, be he a sordid hunter after certificates or a true seeker after knowledge. The authors have treated their subject scientifically, and yet with few technicalities, hence their work should appeal to a large public. Beginning with a chapter on air, they pass to others on water and food, and then to soils, sites, and buildings. The fifth chapter is concerned with drainage, after which are treated personal hygiene, infection and disinfection, parasites, climate and weather, and finally vital statistics. It will be seen from this that the subject is not treated in all its bearings; nevertheless, what is included in the manual forms an excellent basis for further study. Students who use the book will find it a pleasant road to knowledge, and they may confidently put their trust in its contents.

We note that here and there the authors, like many other writers on hygiene, do not sufficiently distinguish between heat and temperature. For instance, on p. 283 it is written: "At the ordinary temperature of the air, water boils at 212° F., and the moment the temperature falls below that heat, steam condenses." In this sentence the word heat is used in the sense that a cook employs it, not as a scientific man should write it.

Dr. Reynolds' primer deals with those portions of hygiene which concern the health of the household. If its contents were more widely known, the mortality from preventible disease would be greatly diminished. The greatest praise that can be given to a primer is to say that readers of the book will acquire just the kind and amount of knowledge to make them, like Oliver Twist, hunger for more. This commendation can safely be given to Dr. Reynolds' little volume, which is a model of what an introduction to hygiene, suitable for the general reader as well as the elementary student, should be.

Fur and Feather Series.—The Grouse. By Rev. H. A. Macpherson, A. J. Stuart-Wortley, and George Saintsbury. Edited by Alfred E. T. Watson. (London: Longmans, Green, and Co., 1894.)

IN the book before us the grouse is regarded from three different standpoints, and treated accordingly. In the first, the Rev. H. A. Macpherson introduces us to his natural history from the point of view of sport, telling us, after he has devoted a chapter in praise of the bird, the manners and "private life" of the grouse; the enemies with which it has to deal; the variability of the plumage in which it is wrapped, and the methods by which grouse are captured by "becking." These chapters are full of anecdotes and thoroughly readable, and they make one long to hear the cocks uttering their clear ringing "Er—eck—kek—kek! wuk, wuk wuk."

The second part is devoted to the shooting of the bird, and is contributed by Mr. A. J. Stuart-Wortley, who handles the subject in a straightforward manner.

We might here discuss at length the contents of the seven chapters on this subject, but we will leave it to the reader to find out for himself what the author has to say on such subjects as Scotch and English driving, ground stock and poaching, records and remarks, shooting over dogs, &c.

The third and concluding section of the book deals with the last, but by no means the least important, stage of the grouse—his presence on the dinner table. Mr. George Saintsbury completes his task well in laying before the reader the numerous and widely different methods of cooking. Not only is the treatment applied to the bird as a whole, but also to such variations as grouse soup, *quenelles*, *croquettes*, *bouchées*, &c.

Summing up then in a few words, we may say that we have nothing but praise to bestow on the book, which is a very valuable contribution to natural history, and worthily keeps up the reputation of the admirable series of which it forms a part. Every naturalist and every carrier of the gun will find it delightful to read, and at the same time will, no doubt, receive many useful wrinkles. Besides the text being all that could be desired, the illustrations are really excellent. They are after the drawings of Mr. A. J. Stuart-Wortley and Mr. A. Thorburn, and were designed under the supervision of the first named.

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.*]

Has the Case for Direct Organic Adaptation been fully stated?

THE heading of this letter is in the form of a question for the following reasons: (1) It is impossible to keep pace with the literature on the subject of Evolution while engaged on any other absorbing work; and (2) so many giants have been engaged in the discussion, that it requires courage even to suggest that a point has been overlooked. It seems to me that nothing could be added to Herbert Spencer's convincing arguments that acquired characters must somehow be transmitted. I wish merely to suggest a method of describing this transmission which I have never yet seen in print, and which, I must think, is not generally recognised, inasmuch as it modifies Weismann's "contradictory facts" into not insuperable difficulties.

While studying the Phyllopod Crustacean Apus, I came to the conclusion that it might be derived from an Annelid which bent its head segments round ventrally, and pushed the food into its mouth with its parapodia. Simple as the suggestion may seem, the facts are indisputable that Apus *can* be so deduced, and further, that there is a considerable mass of evidence to show that it actually was so deduced.[1] If so, we should have one group of animals, the Crustacea, developed from another, the Annelida, not primarily by the summation of a long series of small variations by the action of Natural Selection, but by the active adoption on the part of a portion of the latter of a special manner of feeding. We may perhaps briefly describe the process as follows. A certain number of Chætopod Annelids found themselves in a region where the most favourable diet was only to be obtained in the manner described; the mouth had to be turned down ventrally so as to open backwards, and the lateral parapodia (bordering it in its new position) raked the food together and pushed it into the mouth. Generations of these Annelids would be produced in the same region, and would, in response to the same stimulus, practise the same method of feeding. Natural Selection would perfect the habit, and also *inevitably perfect it earlier and earlier in the lives of succeeding generations.*

But here, it will be said, we have ultimately to call in the aid of the transmission of acquired characters by inheritance. Yes; but this inheritance comes in at the end of a long series without appreciable break in the regular sequence. The last stage of individual acquirement is when the very youngest animal capable of feeding adopts the perfected habit as it first feeding act—in response, that is, to the same stimulus from the environment which led its parents to adopt it. The very next stage is that in which the young animal places its head segments in the right position prior to being able to feed. Here we may assume either that the "instinct" has been inherited, or, considering that the possible positions of the head segments are not numerous, that Natural Selection winnowed out all those

[1] I have endeavoured to accumulate this evidence in the following publications:—"The Apodidæ," NATURE Series, 1892, and "The Systematic Position of the Trilobites," in the *Quarterly Journal of the Geological Society*, August 1894.

whose heads were not ready. I prefer the former hypothesis, for it is not, in this case, the inheritance of characters casually acquired by a few chance individuals, but of characters which have been regularly acquired by the race for several generations as an active organic adaptation to the environment.

It is needless here to multiply illustrations, but this and kindred cases have led me to ask whether too much attention has not been paid to single organisms and the modifications of chance individuals, whereas if a whole colony of similar organisms invade a new region, all have to adopt new habits of life; the young members of the colony and the new young continually born, being plastic, will, before they are adults, show marked structural modifications in adaptation to these new habits. They are actively modified by these functional adaptations to their environment. Natural Selection will winnow out those who do not keep in training, and at the same time infallibly compel the successive generations to perfect themselves earlier and earlier. We should thus have stages (but without appreciable breaks in the sequence) in this evolutionary process. (1) The young are born and continue for some time like the ancestors of the group, while the adults show considerable structural modification; (2) the new-born young resemble the ancestors of the group, but commence early to show the functional adaptations of the adults; (3) the new-born differ slightly from the ancestors of the group, inheriting (or possessing "accidentally") slight modifications in the right direction which enable them still earlier to perfect the necessary adaptation; (4) the young are born with the structures necessary to the immediate adoption of the habits required by the environment.

It seems to me that, in this way, we actually have the transmission of acquired characters by inheritance, this inheritance coming in as a natural term at the end of a long series of individual acquirements. The prime factor in the evolution of new forms is, therefore, the vital response to the environment of living colonies of exquisitely sensitive organisms; Natural Selection not only perfects, but drives the resulting modifications back earlier and earlier in the life-history of each individual of the colony *until they are inherited.*

This principle, it seems to me, explains the degeneration of structures which are "only passively functional," such as a hard shell. If the environment no longer requires a shell, it will not be maintained. It is inherited, say, from ancestors, but each fresh generation, or in the case of the Crustacea, each moult, gives a new start. If the shell owed its origin to the inorganic environment, it would cease to be developed when the special stimulus to its production were withdrawn, for the skin which secretes the shell is passively functional only so far as the organism is concerned; as a living tissue it is actively responsive to its environment. Or again, the shell owed its origin to the protection it afforded from enemies, and thus partly to the survival of those which accidentally had slightly thicker skins; but partly, and I think chiefly, also to the powers of the skin as a complex tissue to resist the attacks of the many small enemies, such as animal and vegetable parasites, which are a constant element in almost all environments. In this case, also, with each generation or moult we have a fresh start; on the removal of the constant irritation from these enemies, the energies of the animal would be otherwise employed than in re-developing its shell.

In order to account for the progressive or retrogressive modifications in the sterile workers of Hymenopterous colonies, we have in the same way to assume the functional modification of the plastic young as the prime factor; Natural Selection not only perfects these modifications, but *drives them back earlier and earlier in the life histories of the individuals.* We can thus understand that a stage might be reached when the difference of the food administered to the larva might modify its course of development. The structural modifications of the workers in this case are not inherited, but they are also not primarily due to Natural Selection, but to the response of organisms *in ever-recurring plastic series* to the requirements of their environment.

Again, the ceaseless efforts of the young individuals of a colony to adapt themselves to a new environment can alone, it seems to me, account for the possible utilisation of congenital variations, which are useless in themselves without concomitant variations. These latter will be acquired by the efforts of the organism, so far, that is, as to render the former functionally useful.

On the other hand, the "time" difficulty in evolution admits of easy solution if it can be shown that groups of organisms actively respond to changes of environment, as plants adapt themselves to a new surface by the plasticity of their growing shoots. Further, the difficulty that organisms are known to have remained practically unchanged through immense geological periods, is explained by the supposition that their environment must have also remained practically unchanged.

For the solution of many of the difficulties in evolution, we have then to look to the functional response of *colonies* of organisms, and of the living parts of such organisms to their respective environments. This power of adjustment accounts not only for the formation, but also for the maintenance of species. The force of Heredity has been overstated, while the power of immediate vital response of delicately balanced organisms to every slight change in the environment has been very much understated. If we keep in view the ever-recurring generations of plastic young, the direct stimulus of the environment is seen almost necessarily to be a force of prime importance perpetually overmastering the somewhat exaggerated rigidity of species attributed to heredity. There is no such thing as rigidity; everything is rather in a state of flux. Is this unending variation, always in adjustment to the environment, due to Natural Selection taking advantage of the occasional accidental slips in an otherwise rigid heredity? or, is it due to the direct response of organisms in a state of finely balanced equilibrium? This latter seems to me the more probable, the resulting structural modifications being, on the one hand, hindered by Heredity; on the other, if the conditions require it, hastened and perfected by Natural Selection. This hastening action of Natural Selection leads inevitably to inheritance.

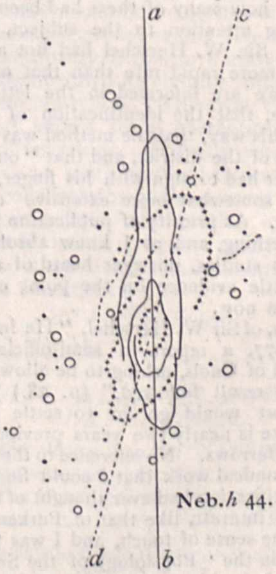
The evolutionary theories known as Lamarckism and Darwinism, only break down when they are supposed to be mutually exclusive. Is it not possible to unite them somewhat in the manner here suggested? H. M. BERNARD.

Natural History Museum, September 17.

The Great Nebula in Andromeda.

IN reference to Dr. A. A. Common's review of Dr. Roberts' beautiful collection of celestial photographs (NATURE, No. 1297, September 6), where he says "There is a fair presumption that in course of time the rotation of the outer portion (of the great Andromeda nebula) may perhaps be detected by observation of the positions of the two outer detached portions in relation to the neighbouring stars," I wish to point out that changes of this kind will perhaps be detected much sooner than it is generally expected.

In the accompanying drawing (presented May 2, 1894, to the *Société Astronomique de France*), *a–b* indicates the outline of



the small elongated nebula *h* 44, as it was seen by Trouvelot at Cambridge (Mass.) in 1874; *c–d* the limits of the nebulosity on Roberts' photograph (1889); the circular spots are stars, recognisable in the drawing. Unless this part of the Trouvelot drawing—the excellence of which is stated by Dr. Roberts himself—be very incorrect, the nebula would seem to have turned about 15° from left to right. The globular nebula (M. 32) to the other side of M. 31, seems also to have slightly shifted its position.

Evidence of the reality of such changes is of course only obtainable by comparing three or more photographs taken at comparatively wide intervals. In the meantime, this short notice in NATURE may call the attention of photo-astronomers to this interesting point.

Dordrecht, September 14. C. EASTON.

On the Identification of Habitual Criminals by Finger-Prints.

A PARLIAMENTARY Blue Book on "The Identification of Habitual Criminals," which has recently been issued, reports on *The Finger-Print System*, stated to have been "first suggested, and to some extent applied practically, by Sir William Herschel."

The chairman of the committee appointed by Mr. Asquith, whose report contains the above statement, refers me for his evidence on this point to Mr. Galton's work on "Finger-Prints" (Macmillan and Co., 1892).

My "careful study" of the subject is mentioned there, and an article of mine in NATURE, October 28, 1880 (vol. xxii. p. 605), is referred to. It is correctly indexed in the "Index Medicus" for the year, published in 1881, although Mr. Galton spells and indexes my name incorrectly. That article, I believe, is absolutely the first notice of the subject contained in English literature, and the conclusion I reached therein was that the patterns of the skin-furrows, with their distinctive loops, whorls, and lines, breaking and blending like the junctions in a railway map, were capable of being readily used as a reliable and permanent basis for the "scientific identification of criminals." I conclude my paper with the statement that "There can be no doubt as to the advantage of having, besides their photographs, a nature-copy of the for-ever unchangeable finger-furrows of important criminals."

Sir William Herschel wrote in NATURE, November 25 of the same year, alleging that he had "been taking sign-manuals by means of finger-marks for now more than twenty years." It does not yet appear that anything had been published on the subject by that gentleman till my contribution called forth his letter a month afterwards. The collections made by Sir W. Herschel were recently placed in Mr. Galton's hands, and that writer states that "they refer to one or more fingers, and in a few instances to the whole hand, of fifteen different persons." ("Finger-Prints," p. 9.)

It is not stated how many of these had been imprinted prior to my first calling attention to the subject. At present it would seem that Sir. W. Herschel had not accumulated the impressions at a more rapid rate than that of one person in two years! As we are informed in the letter to NATURE, referred to above, that the identification of pensioners had been secured in this way, that the method was in use in all the registration offices of the district, and that "on commitment to gaol, each prisoner had to sign with his finger," I should have expected that a somewhat more extensive collection might have been secured. As priority of publication is generally held to count for something, and as I knew absolutely nothing of Sir W. Herschel's studies, nor ever heard of anyone in India who did, some little evidence on the point of priority would be of interest even now.

Mr. Galton says, of Sir W. Herschel, "He informs me that he submitted, in 1877, a report in semi-official form to the Inspector-General of Gaols, asking to be allowed to extend the process; but no result followed." (p. 28.) A copy of that semi-official report would go far to settle the question of priority, as its date is nearly two years previous to my having noticed the finger-furrows. No reference to them was then to be found in any anatomical work that I could find access to, and no writer on identification had ever thought of them as a means to that end. My interest, like that of Purkenje, arose from a special study of the sense of touch, and I was then lecturing to medical students on the "Physiology of the Senses." Having myopic eyes which enable me to write with ease the Lord's Prayer three times in the space of a sixpence, I soon noticed the unique patterns which the papillary ridges formed. I happened to be studying the prehistoric pottery of Japan at the same time, and became interested in observing that these patterns were similar, but, I thought, finer and more slender than those of the present day, which pointed, I conjectured, to the employment of children in early fictile art. However that may be, my knowledge of the subject had a natural and independent genesis.

The subject of identification by this means has been brought under the notice of the authorities on criminal matters of different countries by me from time to time, and some years before Mr. Galton's work was published, Scotland Yard placed one of its most enlightened officers in communication with me on the subject. Inspector Tunbridge studied the subject with me during a forenoon. Even in 1880, I prepared copper-plate outlines of the two hands, accompanied with instructions as to obtaining finger-prints, and some two chief points on the palm, where the rugæ are characteristic. Sir W. Herschel's letter mentions prints of one finger only as being obtained from prisoners on commitment. On page 79 of the Blue Book mentioned above, "Instructions for taking Finger-Prints" are given for the benefit of prison warders, and the ten fingers are to be printed from, as I have advocated. I may add that I have not the slightest wish to diminish the credit that may be due to Sir W. Herschel. What I wish to point out is that his claim ought to be brought out a little more clearly than has yet been done, either by himself or by Mr. Galton. What precisely did he do, and when? HENRY FAULDS.

The Tetrahedral Carbon Atom.

YOUR reviewer, in his notice of my "Elementary Lessons in Organic Chemistry," takes exception to the statement that the carbon atom has been hypothetically regarded as tetrahedral in shape; he is presumably unacquainted with the criticisms of Lossen (*Berichte* 20, p. 3306) on Wislicenus's memoir, with Wislicenus's reply[1] (*Berichte* 21, p. 581), as well as with the pamphlet of Wunderlich ("Configuration organischer Moleküle," Würzburg, 1886); he need not, however, search "the whole range of stereo-chemical literature" for references of this kind, as there is in the "Handbuch" of V. Meyer and Jacobson, pp. 433-436, a tolerably full discussion as to the ultimate cause of stereo-isomerism in carbon compounds, where it is stated (p. 434) that "the carbon atom may be regarded as a mass of finite extension in space, of any shape, with four points on its surface corresponding to the corners of a regular tetrahedron as the units of affinity."

Most writers on stereo-chemical subjects prefer to speak of the tetrahedral arrangement in space of the four valencies of the carbon atom, rather than of the tetrahedral shape of the carbon atom itself; but if the "valencies" are sufficiently material to have a definite position in space, they may fairly be regarded as parts of the carbon atom, which then becomes of finite size, and *for the purposes of stereo-chemistry* essentially tetrahedral in shape. This form of statement has the merit of simplicity, and is in itself less objectionable than the idea of "valencies" directed towards the corners of a tetrahedron; at the same time, I freely admit that the statement errs on the side of excessive simplicity, and is not what would be adopted before a class of honours students.

It is possible to connect the facts of stereo-isomerism to some extent by a series of separate propositions, and at the same time to avoid any reference to the distribution of the "valencies" in space, or to the finite size of the carbon atom; one of these propositions would be that "two carbon atoms connected by an ethylene linkage are no longer free to rotate round the axis which joins them"; but so soon as an attempt is made to unite these separate statements into one hypothesis, or to assign any reason for the proposition just quoted, it is impossible (as it appears to me) to escape from the dilemma; of the two alternatives, I think most chemists, who have not become blinded by long usage to the gross misuse which the word "valency" has suffered, will prefer to regard the carbon atom as finite in size with four points in it, occupying the corners of a tetrahedron, distinguished in some way beyond the rest as regards the action of chemical affinity.

This idea must be made more definite before the average student can derive much help from it in correlating the facts of

[1] Wislicenus says "the atom of carbon may possibly resemble very closely regular tetrahedron in shape."

stereo-isomerism; the essential part of it is retained in the assumption that the carbon atom is stereo-chemically to be regarded as tetrahedral in shape. If any student carries away the notion that this is believed to be the actual shape of the atom, there is no more mischief done than in that student's case who gathers the impression that the two carbon atoms united by an ethylene linkage are held together by two pairs of forces which do not act along the line joining the two atoms, but meet at an angle in empty space. G. S. TURPIN.

Huddersfield, September 24.

Careless Writing.

PROF. TILDEN, in his review, published in NATURE, September 20, takes exception to the loose phraseology adopted by writers on chemical subjects. This is, alas! only too common.

For example, in one of the best works on inorganic chemistry, written by a Professor of Chemistry whose writings are characterised by their logical clearness and philosophic reasoning, one may read:—

"When a molecule of hydrogen acts upon a molecule of chlorine to form two molecules of hydrochloric acid gas, 44,000 c. of heat are evolved." Of course, nobody can fail to understand what is meant. But as the words stand, it is certainly one of the most remarkable feats of science, and makes us feel that some happy mortal has succeeded in refining his faculties down to the degree of fineness, popularly ascribed only to a certain species of "demon." F. G. DONNAN.

Holywood, Belfast.

ON THE DOCTRINE OF DISCONTINUITY OF FLUID MOTION, IN CONNECTION WITH THE RESISTANCE AGAINST A SOLID MOVING THROUGH A FLUID.[1]

II.

§ 6. IN every case in which vacuum is formed at an edge of a solid moving in an inviscid incompressible fluid, under pressure constant at all infinitely great distances from the solid, a succession of finite individual vortices is sent from the edge into the liquid, *and the motion is essentially unsteady*. Each individual vortex has a finite endless vacuum for its core instead of the rotationally moving ring of fluid of the Helmholtz vortex ring. But it should be noticed that it would not be rings of vacuum, but bubbles, that would in many cases be first detached from the solid; that by the tumultuous collapse of bubbles they become rings; and that the case in which the collapse of a bubble, in our ideal fluid, could be completed to an annulment of volume, is of necessity infinitely rare; and that the case in which, when a bubble becomes a ring by the meeting of two points of collapsing boundary, there is exactly no circulation through the aperture, is infinitely rare.[2]

§ 7. In the case of our circular disc, it would be circular vortex rings that, if the water were inviscid, would be shed off from its edge when the depth is less than 63 feet. If the depth is very little less than 63 feet these rings would be exceedingly fine, and would follow one another at exceedingly short intervals of time. Thus quite close to the edge there would be something somewhat like Stokes' "rift," but with a rapid succession of vacuum rollers, as it were; and *no slipping* between the portions of the fluid on its two sides.

§ 8. At greater depths than 63 feet, if the water had absolutely no viscosity,[1] the motion would be continuous and irrotational, as described in § 4, text and foot-note: but any degree of viscosity, however slight, would, if the edge were infinitely sharp (instead of having a radius of curvature of 1/2000 of an inch, as has our supposed disc), give rise to a state of motion in its neighbourhood somewhat like to Stokes' rift,[2] "a surface of discontinuity extending some way into the fluid," but with the difference that there is no slip of fluid on fluid. A trail of rotationally moving liquid, a Helmholtz' "vortex sheet" of exceedingly small thickness, is thus left in the wake of the circular edge; which, while becoming thicker as it gets farther from the edge, becomes rolled up in a wildly tumultuous manner, giving the appearance of an irregular crowd of detached circular ring-vortices. This crowd follows the disc at an ever diminishing speed and widens outward farther and farther, and inwards encroaches more on the comparatively undisturbed middle of the wake, as it is left farther and farther behind the disc.

§ 9. Whether as in § 7 for an ideal inviscid incompressible fluid, or as in § 8 for a natural liquid such as water, the "wake," that is to say, the fluid on the rear side of the plane of the disc, as far as it is sensibly affected by the motion of the disc, must be as described in the last sentence of § 8. The rear of the wake is always moving forwards, that is to say, following the disc; but at a continually diminishing speed. Hence, if the disc has been set in motion from rest some finite time, t, ago, the whole wake must be included between the plane from which the disc started, and the plane in which the disc is now, at the time when we are thinking of it. These two planes are at the finite distance, Vt, asunder. In other words the wake extends to some distance less than Vt, rearwards from the disc.

§ 10. The shedding off of vortex rings from the edge of the disc, to follow in its wake at less speed than its own, essentially gives a contribution to negative pressure on the rear side of the disc equal to $\frac{d}{dt}\Sigma\kappa$; where $\Sigma\kappa$ denotes the sum of the circulations of all the coreless ring vortices, or of all the rotationally moving liquid, which have or has left the edge since the beginning of the motion. This, with the commonly assumed velocities of the fluid on the two sides of the rigid plane, seems insufficient to account for the excess of observed pressure above that calculated for a long blade by Lord Rayleigh's formula[3] referred to in my letter to NATURE, "Towards the Efficiency of Sails, &c.," and leaves some correction to be made on those assumed velocities. But the working out of this interesting piece of mathematical hydrokinetics must be deferred for a continuation of the present article in which supposed discontinuity of fluid motion, extending far and wide, as taught by many writers in many scientific papers and text-books since Stokes' infinitesimal rift started it in 1847, will be considered. KELVIN.

(*To be continued.*)

[1] Continued from p. 525.

[2] The whole subject of the motion of an incompressible inviscid fluid with vacuum on the other side of the whole or any part of its boundary is of surpassing interest. Consider for example an open fixed basin, with water poured into it and left not quite at rest under the influence of gravity; swinging slightly from side to side, let us suppose for example: the water perfectly inviscid, and vapour-less, but may be either cohesional or cohesionless; and there being perfect vacuum over all its free surface. Very soon it will certainly throw up a drop somewhere: and before very long it will become covered with spin-drift and will thus illustrate Maxwell's important allegation (which I believe to be true though it has been much doubted), that any conservative system must "sooner or later" pass through every possible configuration.

[1] Viscosity is resistance to change of shape in proportion to the speed o the change.

[2] Stokes, "Mathematical and Physical Papers," vol. 1. p. 310.

[3] In lines 9 and 10 of the printed letter (NATURE, Aug. 20, 1894, p. 426), for "something like five or ten," substitute 4·8. I unfortunately had not Lord Rayleigh's formula by me at the time the letter was written.

MR. SCOTT ELLIOT'S RUWENZORI EXPEDITION.

ABOUT three years ago, in NATURE (November 5, 1891), I gave an account, rescued from an American periodical, of the botanical results, slender enough it is true, but not without interest, of the Emin Relief Expedition, as described by Major Jephson. The most important feature was undoubtedly the small collection brought away "for Emin Pasha to classify" by Lieut. Stairs from "a high altitude on the slopes of Ruwenzori, or the Mountains of the Moon."

Last year Mr. Scott Elliot, an accomplished botanist and experienced African traveller, submitted to the Government Grant Committee of the Royal Society a scheme for an extended plan of botanical exploration in Central Africa. On the advice of the Board for Botany, Mr. Scott Elliot undertook the investigation of Ruwenzori, and through the kind aid of Sir John Kirk, such official facilities as were possible were obtained on his behalf.

Mr. Scott Elliot, not without many difficulties, has now reached his destination. The following letter, which is communicated to NATURE at his request, raises a high expectation that he will succeed in thoroughly investigating the flora of this interesting region. It is a matter of sincere hope that his health will be spared for the task. Unfortunately the time is far distant when, as prophesied by Mr. Stanley, the "tender-hearted botanist" may be "conveyed from point to point without danger to his valuable life." The honour is all the greater to a man of by no means robust physique, who in the pure interests of science is willing to take his life in his hand in the prosecution of such a task.

W. T. THISELTON-DYER.

Royal Gardens, Kew, September 25.

Ruwenzori, May 2, 1894.

I arrived here on April 1, but have unfortunately been able to do very little, as I have had severe fever. I may not have another opportunity of writing for a long time, so send this now. My route has been through Kavirondo, Usoga, and Uganda to Buddu, through Buddu to Karagwe, and thence diagonally across Ankobe to Toru. I find Uganda, Buddu, and Toru to consist of a plateau apparently gneiss and granite, about 4000–4500 feet high in most parts, but about this part of Toru 5000 or even 5300 feet. The whole of this plateau is cut up into innumerable swampy rivers, due to the comparative slow gradient of these rivers (the Victorian Nyanza being only 3850 feet). In Karagwe and Ankobe this plateau is covered by a series of folded schists and shale which extend with one break from Kitangule to within eight miles of the Albert Edward Nyanza, where the granite plateau is reached again. These schists are at 80°–90° dip, and strike usually 20°–30° east of north. A curious little chain of small volcanic craters, running east and west nearly, appears in the midst of the granite at Vijongo (on Lugard's map), that is, at the base of Ruwenzori, but I have not been able as yet to see much of the geology of Ruwenzori itself. The flora over the whole of this country up to 6000 feet is identical, and even at 6000 feet there are but few new species. It seems probable to me that this flora extends right down to the Zambesi. I have been able to get a fair number of species representing it, but in what condition they will reach England remains to be seen. Of trees there are very few. A tree ***Euphorbia*** and an ***Erythrina*** are the commonest. The most objectionable is a bamboo-like grass, often twenty feet high, which makes travelling most annoying. Another conspicuous plant is an Acanth with handsome red spikes of flowers and very large prickly leaves. There are two or three Helichrysums, numerous Commelinas and twining *Leguminosæ*, and, strangely enough, a *Rubus*, a buttercup, and three *Umbelliferæ*. I find also the same beetles, butterflies, and dragonflies everywhere.

The country as a whole seems very fertile, and the population is probably one-hundredth part of what it might be. The swamp rivers alluded to are probably the most extensive natural rice-fields in the world; but rice has only been grown in a very half-hearted manner. The banana supplies all the wants of the people. Tobacco could also be grown anywhere, and, as far as one can judge from the native plant, a very good kind could be produced. Coffee could also be grown, and cotton, and, in fact, most of the common tropical plants. Kasamaga, the king here, tells me he wants Europeans to settle here and teach his people; and a young fellow who is disposed to rough it, and fond of sport, might do very well here at Ruwenzori. He could support himself the first few years by ivory (shooting and trading), and by the time his plantation came into bearing there ought surely to be communication with the coast. A curious fact in natural history has come about here. Kabbarega has eaten up all the cattle in the country. There is scarcely a fowl left, and in consequence lions and leopards have taken wholesale to man-hunting. They have completely changed their manner of hunting in accordance with this. Usually speaking they are continually roaring on the trail, but here neither ever utters a sound, and though I have had two men injured, and been within a hundred yards of another man who was carried off, I heard nothing.

Mapping is very difficult here; the compass shows the most extraordinary variations, and the rivers are almost impossible to trace, even from a great height, as where I am now.

I have not been able yet to get at the higher flora. One curious fact is that the woods on Ruwenzori very closely follow the ordinary morning clouds and mists; these are usually at the same line every morning, and mount to the top towards evening. This line of wood or cloud is not, however, horizontal, but is highest at the main mass, and slopes gradually as the mountain chain sinks in height.

(Signed) G. F. SCOTT ELLIOT.

THE PHYSIOLOGICAL ACTION OF THE PARAFFIN NITRITES.[1]

THE valuable investigations described in this communication to the Royal Society have been made to determine more exactly the mode of action of paraffinic nitrites, and the part which the nitroxyl group NO_2 plays in their physiological action, and also to throw light on the effect of variations in their molecular constitution. For these objects a series of careful observations have been made as to the action of ten of the fatty nitrites on (1) blood pressure, (2) pulse frequency, (3) respiration, (4) striated muscle tissue.

The compounds selected for examination included the nitrites of methyl and ethyl, the primary and secondary propyl nitrites, the primary, secondary, and tertiary butyl nitrites, and three amyl nitrites (α and β isoprimary, and tertiary amyl nitrite). By this selection it has been possible to compare the action of a series of substances containing an atom of NO_2 united respectively to CH_3, C_2H_5, C_3H_7, C_4H_9, and C_5H_{11}, and thus to determine the modifying influence which these radicals exert on the action of the NO_2 group. It has also been possible to ascertain the effect produced by a modification of arrangement of the molecules in nitrites having the same composition as, *e.g.* in primary and secondary propyl nitrite,

$$CH_3CH_2CH_2NO_2, \text{ and } (CH_3)_2CHNO_2$$

It has long been known that the fatty nitrites lower blood pressure, but opinions have differed as to their mode of action, Filehne considering that this lowering is caused by a paretic influence on the vasa motor centres, whilst Brunton looks upon it as due to a direct effect on the vessels themselves. Cash and Dunstan are led by their experiments to range themselves on the side of

[1] *Phil. Trans.* vol. clxxxiv. (1893), B, pp. 505–639. A paper by Dr. J. Theodore Cash, F.R.S., and Prof. Wyndham R. Dunstan.

Brunton, for they find that if the presence of amyl nitrite is confined to the vessels of the brain alone, a fall of pressure does not take place, but it does occur if blood containing the nitrite circulates in the peripheral vessels of the body, even though the access of any nitrite to the brain is prevented. They likewise find that nitrites are capable of influencing vessels in the area supplied by the splanchnic nerves after section of these nerves—another proof that the action of the nitrites is peripheral.

The part which the group NO_2 plays in its fatty compounds they have sought to determine by ascertaining quantitatively the comparative amount of influence which each nitrite exerts on blood pressure, pulse frequency, and respiration, when introduced into the circulation of anæsthesised cats, by inhalation or by injection into the arterial or venous system, and also by ascertaining the comparative effect of paraffinic nitrites on the pulse frequency in man.

The quantitative method is doubtless open to some fallacies, but from the extreme care which has manifestly been taken in conducting the experiments, and the laborious manner in which they have been repeated, it seems certain that the results are in the main reliable. With regard to the influence of the nitrites in accelerating the beat of the heart, it is shown that physiological activity increases with molecular weight; amyl nitrite is more powerful than butyl nitrite, butyl than propyl, and so on, methyl being the weakest of all.

The order in which the paraffinic nitrites reduce blood pressure in amount is somewhat, though not quite the same, as that in which they accelerate the pulse, but important exceptions occur, especially in the case of methyl nitrite, which occupies a higher position as a pressure reducing agent than it does as a pulse accelerator. On the other hand, as regards duration of subnormal pressure, the order is quite altered, the nitrites which depress blood pressure to the greatest extent acting for the most part for the shortest time.

The authors have also endeavoured to determine the comparative influence of the various nitrites on striated muscle by exposing the excised gastrocnemius and triceps muscles of frogs to equal quantities of their vapours, and recording the extent and duration of contraction produced with or without electric stimulation. This method is open to the objection that hydrolysis of nitrite vapours occurs very rapidly in the presence of aqueous vapour, nitrous acid being produced. Now, muscle tissue is very susceptible to the influence of acids, and it seems by no means certain that the contractions recorded may not have been in part, at least, due to the acid evolved from the nitrite decomposition. With one exception (propyl nitrite) it was noted that the nitrites with low molecular weight were the least powerful in causing muscle contraction, but they acted for the longest time.

Concerning the effects which constitution of the molecule apart from composition has, it was noted throughout that when the effects of primary, secondary, and tertiary nitrites having the same composition were compared, the secondary nitrite was found to have a more powerful influence on pulse acceleration, blood pressure, and muscular contraction than the primary, and the tertiary than the secondary.

The fact that the acceleration of the heart caused by the various fatty nitrites increases with their molecular weight indicates, as the authors justly assume, that the quickening action on the pulse cannot be simply conditioned by the amount of nitroxyl in their molecules, even though it may be true that the nitroxyl group itself quickens the heart's action, for the molecule of methyl nitrite, which is the least effective, contains the largest amount of NO_2, whilst that of amyl nitrite, which most powerfully accelerates the heart's action, contains less NO_2 than any of the other nitrites examined. A similar conclusion is drawn with regard to the influence of the nitroxyl element in causing lowered blood pressure. It is further pointed out, that the preponderance of the hydrocarbon molecules in the higher nitrites is not necessarily the cause of their increased influence in quickening the pulse and lowering pressure. There are other possible causes. After considering some of these the authors express their opinion that the more marked effect of the nitrites having the largest molecules but containing the smallest amount of NO_2 is due to their decreased chemical stability. They incline apparently to the view that the actual molecules of the paraffinic nitrites do not accelerate the heart's action and lower tension, and give reasons for believing that they may actually retard the rapidity of the heart's beat. When, however, the molecule is broken up, the nitrite element becomes active, entering, perhaps, into loose combination with hæmoglobin and certain tissues before it is finally oxidised and eliminated.

The lower combinations, such as ethyl and methyl, being, as they suppose, least easily broken up, exercise least power; on the other hand, for the same reason they act for a longer time, both in lowering tension and contracting striated muscle.

To the greater instability of secondary as compared with primary, and of tertiary as compared with secondary nitrites, they attribute their respectively greater power, rather than to the fact that in the secondary and tertiary compounds one and two methyl groups are respectively attached to the carbon combination of the nitroxyl group. Much remains to be done before the inferences drawn from the elaborate investigations, the results of which have been presented to the Royal Society, can be regarded as definitely proved; but this paper adds, in an important manner, not only to our knowledge of the action of the nitrites, but to our comprehension of the manner in which chemical agents influence the tissues, and become of therapeutic value.

THE LATE PROFESSOR J. P. COOKE.

THE death of Prof. J. P. Cooke was briefly announced in these columns on September 13. The following particulars, for which we are indebted to an obituary notice in the *Tribune* of Cambridge, U.S.A., will be read with melancholy interest by the scientific world:—

Josiah Parsons Cooke was born in Boston, October 12, 1827. He was prepared in the Boston schools, and entered Harvard College in 1845, graduating three years later. In the following year he was appointed an instructor, and, in 1851, Erving professor of mineralogy and chemistry, and director of the chemical laboratory of Harvard University, a post he held until his death.

At the time Prof. Cooke entered upon his duties as head of the chemical department at Harvard, the methods of instruction were of the most rudimentary sort. Students in chemistry were required only to hear so many lectures; work in the laboratory was thought unnecessary, its place being taken by the few experiments which the lecturer saw fit to perform before his classes. Now the chemistry courses at Harvard, as at all other American colleges, consist almost entirely of laboratory work. The credit for this change is due very largely to Prof. Cooke.

Prof. Cooke was made an LL.D. by the University of Cambridge in 1882, and received the same degree from Harvard in 1889. He was a Fellow of the American Academy and a Member of the National Academy of Science. He was a popular lecturer, and delivered several courses at the Lowell Institute, one of the best-remembered being that given in 1887 on the "Necessary Limitations of Scientific Thought."

He was the author of a number of books, pamphlets, and scientific papers. Perhaps the best known of his books was his "Religion and Chemistry," published in 1864, which maintained that the designs of a higher intelligence were to be discovered in the province of chemistry. Among other books were: "The New Chemistry," and its companion volume, "Laboratory Practice," reviewed in NATURE, vol. xlvi. p. 99, "The Elements of Chemical Physics," "The Principles of Chemical Philosophy," and "Scientific Culture."

Prof. Cooke was a highly cultivated man, whose attention was directed to many things outside of his own profession. One of his last published papers was written to recommend that scientific men should be educated more broadly. He did not believe in an exclusively scientific education.

His funeral on September 6 was attended by a group of men and women, whose mere presence was the highest compliment that could be paid to the memory of any man. The successors of Longfellow, Lowell, and the brilliant coterie with which Prof. Cooke was so long a part, were glad of the opportunity to show their love and respect for the man who was all but the last of his generation, there being only a very few of his early contemporaries left.

Among the well-known people present were President C. W. Eliot, Profs. H. B. Hill, W. W. Goodwin, Francis J. Child, Josiah Royce, C. L. Jackson, G. A. Bartlett, Edward Cummings, Ira N. Hollis, Dr. Samuel A. Green, Prof. William Watson (one of the secretaries of the American Academy of Arts and Sciences, of which Prof. Cooke was president), Dr. Henry P. Wolcott, and Dr. Benjamin E. Cotting.

NOTES.

MR. FRANK MCCLEAN, writing to Dr. Gill, under date of August 10, has expressed his desire to present a large equatorially mounted telescope, equipped for photographic and spectroscopic work, to the Royal Observatory at the Cape of Good Hope. With this object he has arranged with Sir Howard Grubb for the construction of a photographic refracting telescope of 24 inches aperture, and for an object-glass prism to work with it, having a refracting angle of $7\frac{1}{2}$ degrees and the same aperture as the object-glass. The glass for the object-glass and prism have already been secured, and the definitive order for the instrument was given to Sir Howard Grubb on May 4 last. Coupled with the photographic telescope there is to be a visual refracting telescope of 18 inches aperture. The mounting is to be sufficiently elevated to allow a slit spectroscope, for the determination of stellar motions in the line of sight, to be attached to the photographic telescope, and the gift will include such a spectroscope, as well as an observatory of light construction. Subject to the concurrence of the Lords Commissioners of the Admiralty, Dr. Gill has cordially and gratefully accepted this noble gift to the Cape Observatory.

CAPT. W. J. WHARTON, the hydrographer of the Admiralty, has sent us a copy of a report, drawn up by Mr. P. W. Bassett-Smith, on the results of dredgings obtained on the great bank known as the Macclesfield Bank, in the China Sea. It may safely be asserted that never before has the biological condition of a sunken coral reef in mid-sea been so completely explored. One of the general results of the whole examination, hydrographical and zoological, is that on the whole of the two hundred miles forming the periphery of the bank, there exists a rim of coral in luxurious growth, and at a remarkably even depth below the surface of from ten to fourteen fathoms. Capt. Wharton points out that this evenness of depth is the most striking feature of the chart, and when the great distances are considered, this appears to be a strong argument against any movement of the bottom since the atoll form was assumed. It is at any rate quite evident that from the present time onwards no movement is necessary in order to form in the future a perfect atoll, the simple growth of the coral on the rim sufficing; and that we may have here an instance of a suitable original foundation for an atoll so formed, as pointed out by Mr. Darwin. Mr. Bassett-Smith's examination of the specimens was necessarily very cursory, and it is to be hoped that the mass of material collected may be thoroughly investigated by skilled zoologists at the British Museum, that full value may be obtained for the labour bestowed upon these examinations. The work is so admirable, and the results so important, that we shall return to the subject in a future issue.

AT several London and provincial medical schools, on Monday last, the opening of the winter session was made the occasion for introductory addresses to the students. Dr. Isambard Owen, at St. George's Hospital, discoursed chiefly on the importance of mental training in medical study. He remarked that the method of the physician was the method ordinarily employed in all forms of physical investigation. Science consisted of soundly-drawn conclusions based upon accurately-made observations. Accurate observation was the foundation of all medical work; and Dr. Owen dwelt at some length on the fallacies of ordinary observation, and the scrupulous care needed to ensure exactitude. At St. Thomas's Hospital, the Rev. W. W. Merry delivered an address mainly concerned with Plato's criticisms upon the practice of medicine and surgery in Homeric times. Mr. G. Hartridge offered practical counsel to the students at Westminster Hospital, and, as an inducement to work, remarked that "the Royal Society numbers among its members a large proportion of medical men, a much larger number than all the other professions put together." At Middlesex Hospital, Dr. R. Boxall discoursed upon the relations existing between the public, the medical profession as a whole, and medical charities. Words of exhortation and advice were also offered at St. Mary's Hospital, by Dr. S. Spicer, and at University College Hospital, by Prof. H. R. Spencer. Miss M. Sturge advised the students at the London School of Medicine for Women to cultivate from the first a scientific habit of mind, as its possession was invaluable to the medical profession. Lord Bacon's words, "We must be content to stand before nature and ask questions; nature can only be subdued by submission," were quoted as a clue to the method of work of all great physicians.

THE Council of the Institution of Civil Engineers has issued a long list of subjects upon which original communications are invited. Papers upon any question of professional interest will have their merits considered, even if they do not deal with subjects specified in the list. For approved papers the council has the power to award premiums, arising out of special funds bequeathed for the purpose, the particulars of which are as under:—(1) The Telford Fund, left "in trust, the interest to be expended in annual premiums, under the direction of the council." This bequest (with accumulations of dividends) produces £235 annually. (2) The Manby Donation, of the value of about £10 a year, given "to form a fund for an annual premium or premiums for papers read at the meetings." (3) The Miller Fund, bequeathed by the testator "for the purpose of forming a fund for providing premiums or prizes for the students of the said institution, upon the principle of the 'Telford Fund.'" This fund (with accumulations of dividends) realises nearly £140 per annum. Out of this fund the council has established a scholarship, called "The Miller Scholarship of the Institution of Civil Engineers," and is prepared to award one such scholarship, not exceeding £40 in value, each year, and tenable for three years. (4) The Howard

Bequest, directed by the testator to be applied "for the purpose of presenting periodically a prize or medal to the author of a treatise on any of the uses or properties of iron, or to the inventor of some new and valuable process relating thereto, such author or inventor being a member, graduate, or associate of the said institution." The annual income amounts to nearly £15. The next award will be in 1897. The council will not make any award unless a communication of adequate merit is received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums, no distinction will be made between essays received from members of the institution or strangers, whether natives or foreigners, except in the cases of the Miller and the Howard bequests, which are limited by the donors. There is no specified date for the delivery of MSS., as when a paper is not in time for one session it may be dealt with in the succeeding one.

THE Queen has been pleased, on the recommendation of the Secretary for Scotland, to approve of the appointment of Mr. Angus Sutherland, M.P., as chairman of the Scottish Fishery Board.

THE death is announced of Prof. K. M. Albrecht, of Hamburg, at the age of forty-three. He was the author of several important researches in the domains of zoology and comparative anatomy.

DR. CHARLES L. EDWARDS has been appointed to the Chair of Biology in the University of Cincinnati, Ohio, U.S.A.

AT St. Helens, on Tuesday, Colonel Gamble laid the foundation-stone of an institute which is to form a central library and reading-room and a school for technical education and manual instruction. He has given the site, and will spend £20,000 on the building.

MR. WILLIAM LUNT, of the Royal Gardens, Kew, who acted as botanical collector to Mr. Theodore Bent's expedition to the Hadraumaut Valley, Southern Arabia, has been appointed, by the Secretary of State for the Colonies, Assistant Superintendent of the Royal Botanic Gardens, Trinidad.

SEVERAL earthquake shocks, accompanied by subterranean rumblings, were felt at Dortmund, Germany, on Tuesday morning, and caused some alarm.

AT the meeting of the Royal Photographic Society, to be held on Tuesday next, the medals will be presented to successful exhibitors at the annual exhibition, and the President will deliver an address.

THE new buildings of the Durham College of Science, Newcastle-upon-Tyne, will be opened by the Mayor of Newcastle on Tuesday, October 9.

SUNSHINE is such an untrustworthy quantity in the climate of the British Isles, that it is no wonder that professional photographers have for some time been developing methods for making themselves independent of it. Judging from the extent in which artificial illumination is used in photographic studios at the present time, it seems probable that a few years hence the sun will be largely (if not entirely) disregarded in negative-making. An exhibition of apparatus for illuminating studios, and some of the pictures obtained by means of artificial light, is now being held at the *Photogram* Commercial Museum, and will remain open until the end of this month. A number of interesting exhibits are on view. There are various magnesium lamps, electric lamps designed for portraiture work, and gas-light systems for studios. Two of the most interesting instances of the use of magnesium flash-lamps are to be found in the pictures obtained by Mr. J. C. Burrows in the tin mines of Cornwall, and Mr. H. W. Hughes in the coal mines of the Black Country. The exhibition well deserves a visit.

THE *Weather Review*, edited by Mr. John Eliot, and published every month by authority of the Government of India, always contains an admirable summary of the chief features of the weather in India during the month to which it refers. The annual summary, which has just reached us, contains a discussion of the meteorology of India for the year 1893. The report reminds us that meteorological data in India are chiefly utilised for the following purposes: (1) In the discussion of the prevalence and spread of diseases, more especially of cholera and other diseases of an epidemic character; (2) in connection with agricultural questions, more especially the progress and character of the crops as determined by the weather conditions of the period. In the monthly reviews, all the meteorological facts and data are therefore presented from these wo points of view. For medical statistics India is divided into eleven provinces, which are believed to be fairly homogeneous so far as the conditions of the prevalence of the more common diseases are concerned. According to the second method of arrangement, there are fifty-two meteorological divisions, or areas divided from an agricultural standpoint. By following this plan, the meteorological data available are made to yield the greatest amount of good to the people of India.

QUESTIONS of natural history assume a particular value when they deal with the supply of a popular article of food, and we present, therefore, some conclusions recently arrived at by Mr. F. H. Herrick, of the U.S. Fish Commission, upon the reproductive habits of the American lobster (*Zoologischer Anzeiger*, xvii. No. 454). It is not improbable, as Mr. Herrick suggests, that the habits of the European lobster are essentially the same as those of its American relative. (1) The majority of adult females extrude their eggs during June, July, and August, but a considerable number—probably 10 per cent. of the entire number which breed in the year—lay eggs in the autumn, winter, and spring. (2) The lobster cannot possibly breed oftener than once in two years. (3) The eggs are carried by the mother for ten or eleven months: on the coast of Massachusetts, from the middle of July to the middle of the following June. (4) Sexual maturity is reached occasionally at a length of 8 inches, but sometimes not under 12 inches. The majority, however, are mature when 10½ inches long. (5) The numbers of eggs produced by female lobsters at each reproductive period increase in a geometrical series, while the lengths of the lobsters producing these eggs vary in an arithmetical series. A lobster 14 inches long will produce four times as many eggs at one laying as a lobster of only 10 inches. (6) Out of the 10,000 eggs produced at one time, not more than two arrive at maturity, and even this estimate is probably too high, as the fisheries are now declining.

THE exact measurement of the density of very dilute aqueous solutions to within a millionth of its value, is the subject of a paper by F. Kohlrausch and W. Hallwachs in *Wiedemann's Annalen*. The method adopted was that of suspending a glass globe in the solution by a fine thread, and determining its weight. The thread found most suitable was a single smooth cocoon fibre. Small disturbing fibres or dust particles could be detected by the behaviour of the swinging balance. The stirring was done by means of a glass rod bent into a horizontal ring at the bottom, and carrying a ring of platinum foil. During stirring, the glass body was lifted by another glass ring provided with pieces of platinum wire to prevent the body sticking to it. The thermometer indicated hundredths of Centigrade degrees, and could be read to thousandths by the telescope. The sensitiveness of the balance employed was not excessive, since it gave a deflection of two-thirds of a millimetre for a milligram. The weight of the suspended body was 133·310 gr., and the loss of weight in the solutions was always over 129 gr., so that the thread was not required to support more than 4 gr. The loss of weight in pure water was 129·194 gr. at 17°·50 C., and did not vary by more than 0·002 gr. in five months. The difference in the individual numbers for the loss of weight in any given liquid was 0·11 mg. on the average, which corresponds to about a millionth of the density to be determined. These very accurate determinations brought out some interesting details with regard to the "molecular volumes" of the substances in solution. Phosphoric and sulphuric acids showed a decided diminution of this volume at extreme dilutions, while sugar, hydrochloric and acetic acid, and sodium chloride and carbonate did not show this diminution.

THE *Annales de Chimie et de Physique* for September contains a paper, by M. Henri Bagard, on the thermoelectric force between two electrolytes, and on the Thomson effect in the case of electrolytes. The paper contains a very complete history of the work which has been done on this subject. The author uses a number of thermoelectric junctions joined in series, and measures the electromotive force developed by a given difference in temperature between the hot and cold surfaces of separation between the electrolytes by means of a capillary electrometer. This electrometer was capable of indicating an electromotive force of one-hundred-thousandth of a volt. In order to check the diffusion which takes place at the common surface of the electrolytes, the author uses a porous membrane. By using membranes composed of such different substances as goldbeater's skin and vegetable parchment, it was proved that the membrane had no effect on the electromotive force, except to cause it to diminish slightly with time. Thus the results obtained with a membrane are probably identical with what would be obtained could observations be made without a membrane, and without diffusion and convection currents being set up through the surface of separation. Observations were taken both while the temperature of one junction was rising and again when cooling. The points obtained during the second of these operations often fell below the curve given by the previous set. This effect, which never amounted to a difference of $\frac{1}{10000}$ volt, the author considers to have been entirely due to diffusion. Thermoelectric couples, consisting of solutions of two different salts, and of solutions of the same salt but of different concentration, were examined, and the results obtained are shown by means of curves. In order to examine the Peltier and Thomson effects in the case of electrolytes, small bolometers were employed to measure the change in temperature. The important fact that the Peltier effect is of opposite sign on opposite sides of the neutral point was amply verified, and it appears that the change of sign takes place at the neutral point. In all cases the thermoelectric phenomena, the Peltier effect and the Thomson effect gave results in the case of electrolytes similar to those obtained with metals.

"CREAMERIES and Infectious Diseases" is the title of a short paper which Dr. Welply has had reprinted from the *Lancet*. It is a most useful little pamphlet, inasmuch as it calls attention to a danger which, so far, has escaped public notice. Creameries receive, as is well known, their milk from a number of farms; but after the cream has been removed, some of the skim or separated milk is sent back to the farms, where it is consumed in various ways. The milk received from the various farms is all mixed together, and thus it is not difficult to see how one case of typhoid fever, or some other illness on one of these farms, may not only infect the creamery, but may, by means of the separated milk, infect the whole group of dairies supplying this creamery, thus starting an indefinite number of fresh disease centres. Dr. Welply describes an outbreak of typhoid fever which he traced to a creamery, and to the use of food or milk from dairies which became infected secondarily. In several of the dairies which he visited, he states that he found the dairy-maids acting in the dual capacity of milkers and nurses, and he is distinctly of opinion that the contagium got into the milk from the hands of the dairy-maids. It is clear that unless we can obtain stringent regulations passed, such as are in use in Denmark, Sweden, and Germany, and which our Board of Agriculture have published in their reports on dairy farming in these countries, unless we can procure similar legislative measures, co-operative dairy farming in England will always remain a continual source of danger to the public health. Dr. Welply says "it would be wise at all times to boil separated milk when used as an article of human diet"; we would go still farther, and say that it is undesirable to drink any milk which has not been previously thoroughly boiled, not warmed or brought to the boil, but boiled for several minutes. The National Health Society took this question up some years ago, and issued a short leaflet on the advisability of boiling all milk before use.

LUERSSEN AND HAENLEIN'S *Bibliotheca Botanica* will in future be edited by Prof. C. Luerssen and Prof. B. Frank.

MESSRS. BLACKIE AND SON have just issued part 6 of Prof. Oliver's translation of Prof. Kerner's "Natural History of Plants."

WE have received the Calendars for the Session 1894–5, of the University College, Bristol, the Durham College of Science, Newcastle-upon-Tyne, and the Merchant Venturers' Technical College, Bristol.

THE General Report on the Operations of the Survey of India Department for 1892–93 has just been issued from the office of the Superintendent of Government Printing, Calcutta.

THE June number of *Timehri*, the journal of the Royal Agricultural and Commercial Society of British Guiana, has just come to hand, and contains, as usual, a number of very varied and interesting papers, notably, "The Guiana Orchids," by the editor—James Rodway; "Late Rainfalls, some of their Effects," by James Gillespie; and "Some Enemies of our Canefields," by S. R. Cochran. The society celebrated the fiftieth year of its existence in March of this year, when a successful historical exhibition was held in honour of the event.

THE sixteenth annual meeting of the Greenock Natural History Society was held on September 28, Mr. T. L. Patterson, president, occupying the chair. During the session 1893–94 seven papers were read, viz.: "The Sorghum Sugar Experiments in the United States," by Mr. T. L. Patterson; "A Study of Fungi," by Dr. M. Calder; "Scenes from Australia," by Mr. Thomas Steel; "Gems and Precious Stones," by Mr. James M'Neil; "The Evolution of Navigation and Nautical Astronomy," by Mr. G. W. Niven; "Plants with Angular Stems," by Mr. John Ballantyne, Rothesay; "Notes on the Cladocera," by Mr. M. F. Dunlop.

"SCIENCE is measurement." Mr. J. Lawrence, of 56 Fulham Road, London, evidently believes that the converse of this is true, for he has sent us a "Tell-tale" milk-jug, which London milkmen will probably regard with sorrowful feelings. The object of the jug is to furnish householders with a standard wherewith to judge the probity of their dairymen. The jug is a glass measure graduated at every quarter-pint. Below each pint and half-pint mark three lines are etched showing the thickness of cream which should appear in milk of average quality, in milk of good quality, and in milk of very good quality after the liquid has been allowed to stand for a time. Both the quantity and the quality of the milk can thus be easily tested.

THE Society for Promoting Christian Knowledge have just brought out a second edition of "Our Secret Friends and Foes," by Prof. Percy Frankland, F.R.S. It will be remembered that the volume was the source of a good deal of discussion between some members of the Society, who, with the late Lord Coleridge at their back, announced their intention of retiring from their membership unless the book was withdrawn from circulation, it being, according to their interpretation, written in support of vivisection. That the Society did not yield to the very considerable pressure brought to bear upon them, is evidenced by the appearance of the second edition, which, whilst containing an entirely new chapter on the action of light on micro-organisms, remains otherwise, with the exception of a few (mostly verbal) alterations, unchanged.

MESSRS. CHAPMAN AND HALL will publish, almost immediately, a complete "Text-book of Mechanical Engineering," by Mr. W. J. Lineham, the Head of the Engineering Section of the Goldsmiths' Institute, New Cross. The work consists of nearly eight hundred pages and more than seven hundred figures. The first half is devoted to practical work, viz. casting and moulding, pattern-making, and casting design; metallurgy and properties of materials; smithing and forging; machine tools; marking off; fitting, machining, and erecting; boiler-making and plate-work. The second part of the book deals with theory and examples, the order of treatment being strength of materials; energy and the transmission of power to machines and heat engines; hydraulics and hydraulic machines. The book is not supposed to be an exhaustive treatise on mechanical engineering; nevertheless, it will be a valuable aid to engineering students and apprentices, and engineering draughtsmen generally.

SINCE the publication of "Forthcoming Scientific Books' in our issue of September 20, the following list of announcements has been sent to us by the Cambridge University Press:—"The Scientific Papers of John Couch Adams"; "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "Hydrodynamics: a Treatise on the Mathematical Theory of the Motion of Fluids," by Prof. H. Lamb, F.R.S., new edition; "Catalogue of Scientific Papers compiled by the Royal Society of London," new series for the years 1874–83, vol. xi. in the press; "A Treatise on Geometrical Optics," by R. A. Herman; "An Introduction to Abel's Theorem and the allied Theory," by H. F. Baker; "A Treatise on Geometrical Conics," by F. S. Macaulay; "An Elementary Introduction to Mineralogy," by R. H. Solly; "Euclid's Elements of Geometry," Books XI. and XII., by H. M. Taylor; "Arithmetic for Schools," by C. Smith, with or without answers, second edition; "Key to C. Smith's Arithmetic"; "Practical Physiology of Plants," by F. Darwin, F.R.S., and E. H. Acton; "Practical Morbid Anatomy," by Dr. H. D. Rolleston and Dr. A. A. Kanthack; "The Distribution of Animals," by F. E. Beddard, F.R.S.; "Petrology," by A. Harker; "Text-book of Physical Anthropology," by Prof. Alexander Macalister, F.R.S.; "The Vertebrate Skeleton," by S. H. Reynolds; "Fossil Plants: a Manual for Students of Botany and Geology," by A. C. Seward; "Elements of Botany," by F. Darwin, F.R.S.; "Mechanics and Hydrostatics," by R. T. Glazebrook, F.R.S.; "Electricity and Magnetism," by the same author.

MESSRS. CHARLES GRIFFIN AND CO. have also sent a list of the scientific books they hope to issue during the ensuing season; it is as follows:—"Petroleum," a treatise on the geographical distribution, geological occurrence, chemistry, production, and refining of petroleum; its testing, transport, and storage, and the legislative enactments relating thereto, together with a description of the Shale Oil industry, by Boverton Redwood, assisted by Geo. T. Holloway, with maps and illustrations; "Calcareous Cements: their Nature, Preparation, and Uses," with some observations on cement testing, by Gilbert R. Redgrave; "Griffin's Chemist's Pocket-book": tables and data for analysts, chemical manufacturers, and scientific chemists, by J. Castell-Evans; "Measurement Conversions" (English and French), 28 graphic tables or diagrams, showing at a glance the mutual conversion of measurements in different units of length, areas, volumes, weights, stresses, densities, quantities of work, horse powers, temperatures, &c., for the use of engineers, surveyors, architects, and contractors, by Prof. Robert Henry Smith; "The Metallurgy of Iron," by Thomas Turner; "An Elementary Text-book of Metallurgy," for the use of younger students and those commencing the study of metallurgy, by Prof. A. Humboldt Sexton, with numerous illustrations; "Kitchen Boiler Explosions: why they occur, and how to prevent their occurrence," a practical hand-book, based on actual experiments, by R. D. Munro; "Fibroid Diseases of the Lung, including Fibroid Phthisis," by the late Sir Andrew Clark, Bart., F.R.S., and Drs. W. J. Hadley and Arnold Chaplin, with tables, and eight plates in colours; "Practical Hygiene," including air and ventilation, water, supply and purity; food and the detection of adulterations, sewage removal, disposal, and treatment, epidemics, &c., by Surgeon-Major A. M. Davies, with illustrations; "A Manual of Ambulance," by J. Scott Riddell, with numerous illustrations and full-page plates; "The Hand-Rearing of Infants: a Guide to the Care of Children in Early Life," by Dr. John Benj. Hellier; "Year-book of the Scientific and Learned Societies of Great Britain and Ireland," compiled from official sources, including lists of the papers read during 1894 before Societies engaged in fourteen departments of research. Twelfth annual issue (early in 1895).

ONE of the most striking features of chemical progress at the present time is the rapid advance which is being effected in our knowledge of the compounds of nitrogen. Another compound of primary importance, symmetrical hydrazo-ethane, $C_2H_5NH.NHC_2H_5$, the symmetrical di-ethyl derivative of hydrazine, has been isolated in the laboratory of the Berlin University by Dr. Harries. Prof. Emil Fischer has already obtained the unsymmetrical di-ethyl hydrazine, and Prof. Curtius, to whom we owe the discovery of hydrazine itself, some time ago succeeded in obtaining the symmetrical di-benzyl hydrazine, but hitherto the simple symmetrical fatty hydrazines have eluded isolation. Indeed it is only by a somewhat circuitous, although practically quite easy, series of reactions that symmetrical di-ethyl hydrazine has at length been prepared. A remarkable derivative of hydrazine was first obtained, in which one hydrogen of each amidogen radicle was replaced by the radicle formyl, CHO, and the other by the metal lead, the compound being represented by the formula

```
CHO—N—N—CHO.
     \ /
      Pb
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This substance, a white powder, is readily obtained by reacting with sodium upon di-formyl hydrazine, a compound with which Prof. Curtius has made us familiar, and subsequently decomposing the latter with sugar of lead. The lead compound, when slightly heated in a sealed tube with ethyl iodide, together with sand to maintain porosity, and magnesia to fix the liberated hydriodic acid, is converted into a compound in which the lead atom is replaced by two ethyl groups. This latter compound, a somewhat volatile liquid, is treated with fuming hydrochloric acid, which removes the formyl groups and converts the compound into symmetrical di-ethyl hydrazine hydrochloride, which is precipitated. Upon distillation with caustic potash the free di-ethyl hydrazine passes over at 85°. The new compound is a liquid of pleasant odour, reminding one at the same time of ether and of weak ammonia. It reduces Fehling's solution with great energy upon gently warming, and silver nitrate in the cold. It vigorously attacks caoutchouc. Its hydrochloride contains two molecules of hydrogen chloride, and crystallises well in plates melting at 160°. The symmetrical di-ethyl hydrazine behaves in a most interesting manner with certain oxidising agents, particularly mercuric oxide. The yellow oxide reacts in a most violent manner, but the red oxide affords a more manageable reaction; the products are a large quantity of mercury di-ethyl, $Hg(C_2H_5)_2$, and a smaller quantity of azoethane, $C_2H_5N=NC_2H_5$, the ethyl analogue of the well-known azobenzene. The symmetrical and unsymmetrical di-ethyl hydrazines are clearly distinguished by their reactions with nitrous acid, for while the latter yields di-ethylamine and nitrous oxide, the former affords ethyl nitrite together with a smaller quantity of a nitroso compound.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*, ♂ ♂) from India, presented respectively by Mr. Philip E. Morel and Miss Ling; a Common Marmoset (*Hapale iacchus*) from Brazil, presented by Mr. A. E. W. Burns; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♀) from New South Wales, presented by Lady Isabel Clayton; three Australian Cranes (*Grus australasiana*) from Australia, a Brown Crane (*Grus canadensis*) from North America, an Indian White Crane (*Grus leucogeranos*) from India, presented by Mr. E. W. Marshall; two Californian Quails (*Callipepla californica*) from California, presented by Mr. H. H. Howard Vyse; a Ground Hornbill (*Bucorvus abyssinicus*), from Nyassaland, presented by Mr. H. H. Johnston, C.B.; three Pratincoles (*Glareola pratincola*), four Night Herons (*Nycticorax griseus*), a Great Bustard (*Otis tarda*), South European, presented by Lord Lilford, three Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Mr. C. Stonham; two Cerastes Vipers (*Vipera cerastes*), two Egyptian Eryx (*Eryx jaculus*), a Cliffords Snake (*Zamenis cliffordi*) from Egypt, deposited; A Simonys Lizard (*Lacerta simonyi*) from the Island of Hiero, Canaries, presented by Mr. Sydney Crompton; a Deadly Snake (*Trigonocephalus atrox*) from Trinidad, presented by Messrs. Mole and Urich; an Axis Deer (*Cervus axis*), a Rufous Rat Kangaroo, *Hypsiprymnus rufescens*) born in the Gardens.

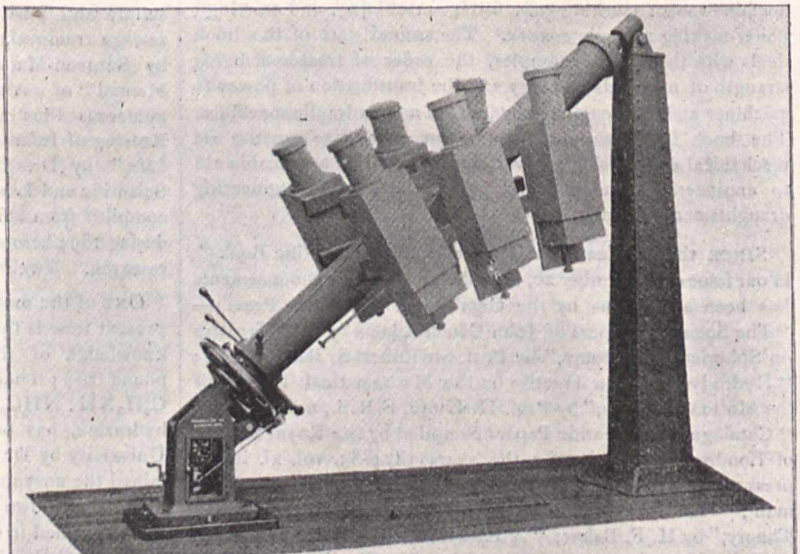
OUR ASTRONOMICAL COLUMN.

AN INSTRUMENT FOR PHOTOGRAPHING METEORS.—Up to the present time meteoric astronomy has had little, if any, instrumental equipment to further its development, the nature of the phenomena rendering simple naked eye observations the only available means of research. It is true that even now we know of a very considerable number of radiant points, and what is more, we have been able to note the daily movements of some of these in the heavens; but this knowledge has only been gained by the great patience and perseverance of astronomers, the most notable being Mr. W. F. Denning. With a thorough knowledge of the constellations, a good globe or star-map, and an accurate eye, he has been able to plot down track after track of these travellers through space, deducing from their paths the points in the heavens from which they are coming.

What will most probably lead to a great advance in the determination of the positions of these radiant points, is the introduction of photography for recording permanently the visible tracks in the sky. There may have been many attempts already for photographing these trails, and the writer himself a few years back, with an ordinary camera, was fortunate enough to catch nine trails on the sensitive plate. The camera being fixed and not equatorially mounted, the star images were consequently curved arcs, and not points. Even on this plate fairly accurate positions of the trails could have been obtained.

A somewhat unique instrument for locating the tracts of meteors and their radiant points, has recently been constructed by Messrs. Warner and Swazey for the Yale University Observatory. The accompanying illustration of the instrument is from *Popular Astronomy* for September.

The illustration shows the polar axis of the "English" form carrying a number of cameras. The axis is of a tubular form, about twelve feet long, the ends working on pivots which are capable of adjustment. The southern support is connected with clockwork, while that at the northern end is supported on a pillar in which are the driving weights in connection with the clock by cords passing under the floor. On the declination axis are fitted two arms which serve as supports to the cameras, three cameras being on the eastern and three on the western side. These cameras are so oriented that they take, in their



respective fields, adjoining portions of the sky, so that altogether they cover a very large area. The instrument is supplied with slow motions, both in right ascension and declination, and the clockwork has an electric control. Whether satisfactory results have yet been obtained, one cannot say, but the apparatus was intended to be used for the Perseid swarm of October last.

SUN-SPOT OBSERVATIONS AT THE POTSDAM OBSERVATORY.

IN the publications of the "Potsdam Astrophysical Observations," Dr. Spörer has previously (No. 17) presented us with the observations of the sun-spots for the years 1880 to 1884. The most recent addition to these records will be found in No. 32, in which are collected the sun-spot observations for the years 1885 to 1893. The observations themselves are given in all details, being grouped together with regard to the period of rotation. These are followed by a brief discussion, from which these notes and extracts have been made.

The following table, bringing together the results relative to frequency and positions (as regards latitude) of the spots may be first given, as many references will be made to the numbers therein :—

Year.	Frequency.			Mean heliographic latitude.		
	Northern hemisphere.	Southern hemisphere.	Both hemispheres.	Northern hemisphere.	Southern hemisphere.	Both hemispheres.
1870	738	765	1503	+17°·0	−18°·9	17°·9
1871	545	605	1150	17·8	14·8	16·2
1872	523	618	1141	16·0	13·2	14·5
1873	323	415	745	13·3	11·2	12·1
1874	249	246	495	11·0	11·2	11·1
1875	108	85	193	11·0	10·4	10·9
1876	44	81	125	10·3	10·0	10·1
{ 1877	48	66	114	8·3	9·7	9·1
{ 1878	30	10	40	7·8	7·0	7·6
{ 1879	11	3	14	8·3	6·1	7·8
{ 1877	3		3	29·3		29·3
{ 1878	1	1	2	34·4	20·2	27·3
{ 1879	23	37	60	24·5	21·9	22·5
1880	218	156	374	20·0	20·3	20·1
1881	318	252	570	18·0	19·9	18·8
1882	366	311	677	15·4	16·9	16·1
1883	286	546	832	11·5	13·4	12·7
1884	373	460	833	10·5	11·9	11·3
1885	198	444	642	10·2	12·2	11·6
1886	103	226	329	9·9	10·5	10·3
1887	53	120	173	8·5	0·2	8·5
1888	22	80	102	5·9	6·9	6·7
{ 1889	12	44	56	6·3	6·2	6·2
{ 1890	2	9	11	3·5	7·9	7·1
{ 1889	6	27	33	25·8	23·3	23·7
{ 1890	64	71	135	22·2	25·0	23·7
1891	383	142	525	19·8	19·9	19·9
1892	453	416	869	15·3	20·2	17·6
1893	437	627	1064	14·4	15·3	14·9

From the table above, it will be seen that the minimum of 1878 was followed after 5·2 years by a maximum in 1884·0. The mean heliographic latitude of the spots at this period of maximum decreased to 12°, which is lower than was the case at the preceding maximum. Following this a minimum in 1889·5 occurred, the precession of spots disappearing at the mean latitude of 7°, and a new series beginning in 1889 at 40° on the southern hemisphere, and somewhat later at 23° and 35° on the northern hemisphere. Higher latitudes were at times recorded, the highest occurring in September 1893 and amounting to 42°. The mean yearly heliographic latitude for 1893 diminished to 15°. For the earlier part of the present year five periods of rotation have given for the mean latitude also 15°, indicating, when compared with the two foregoing periods, a further decrease in the numbers representing the "frequency." The time of maximum then can apparently be placed at 1893·5, but this would most probably have to be altered if the more recent observations show a further rising.

An examination of the Carrington observations also shows this movement in the heliographic latitude. Wolf, to explain it, suggested the existence of currents, which commenced with a minimum on both hemispheres in high latitudes, and continued to the following minimum towards lower latitudes. As indications of these currents, it might be stated that at the times of maximum suitable stripes appear on the meridian, which are for a long time free from spots and faculæ. This suggests that "special channels exist from time to time for the hypothetical currents."

Dr. Spörer next examines the old sun-spot observations for finding out the period from the "rate" of the heliographic latitudes. The cases he takes into consideration show, as he says, "eine genügende Uebereinstimmung mit den neueren Beobachtungen in Betreff des Ganges der mittleren heliographischen Breite während der Häufigkeits perioden. Dagegen scheinen nach dem Jahre 1644 in einen Zeitraume von 70 Jahren wesentlich andere Verhältnisse geherrscht zu haben."

Different records, he goes on to say, agree that from 1645–70 the spots observed were few. After this the number increased, reaching an important maximum in 1716. It was even then remarked (in 1715) that it was curious to note that spots were visible on different parts of the solar disc at the same time. In 1704 and the following year, one case occurred in which spots at the same time, but on two different positions of the disc, were seen; it was here expressly stated that such had not been observed for sixty years. Other instances (two) of this "scarce" case occurred in 1707. In 1716, spots were seen for several days, in eight different places on the disc.

Bringing together the positions of the observed spots, as regards latitude, Dr. Spörer adds that from 1671–1713 none were found in high latitudes. The highest (in 1703) was 19°. Previous to this, from November 1700, the latitude lay between 2° and 12°. At this time higher latitudes had been normal, because from May 1695–Nov. 1700 not a single spot had been observed. For this reason Prof. Wolf is stated to have assumed a minimum (1698·0), and determined the following minimum 1712·0, the authenticated records giving the information that no spot appeared in the years 1711 and 1712.

Some interesting facts may be stated now regarding the spots on the respective northern and southern hemispheres. The deficiency of spots for the former is "noch besonders hervorzuheben." In 1671, during two periods of rotation, a spot (12° N. Lat.) was observed. In 1705 and 1707 a spot is also cited to have been seen, but the northern hemisphere was free from them until 1713, and it was not till 1714 that they were then found to be numerous; thus one can hardly assume that, besides those recorded on the northern hemisphere, more spots in greater number appeared, for Cassini mentioned expressly, from the observation of a spot from the year 1707, "the spot deficiency of the northern hemisphere," and at the same time remarked "that the constitution of the northern hemisphere was different in a certain manner from that of the southern hemisphere." A glance at the records for the period 1644–1670 also shows that in the "period of seventy years on the northern hemisphere certainly no periodicity of spots had occurred."

The behaviour of the two hemispheres, as regarded in the light of more recent observations, is also very striking, and since 1883 the southern hemisphere has received the greater preponderance of spots. This continued to be the case during the minimum, and only discontinued when a rise of the number of spots had begun on the two hemispheres. The year 1891 was a critical year, on account of the astonishing change that was brought about.

While on the southern hemisphere the number of spots only slowly increased, that on the northern hemisphere attained considerably greater proportions. The resulting ratio for the spots during the year 1891 was as 8 : 3 for the northern and southern hemisphere respectively. The nature of this preponderance for the northern hemisphere was not more than temporary, for in 1892 it had greatly diminished, and the southern hemisphere had again attained its old position. Last year the proportion for the northern and southern was as 7 : 10.

The division of the spots with regard to their heliographic latitude displays also differences for the two hemispheres. A table bringing together the results for five periods of rotation indicates a great difference in the mean values of the heliographic latitudes; this difference, on the other hand, is to a certain extent eliminated if one deals with the yearly mean.

Reference is made also to the great change that occurs in the "Rotationswinkel" of some spots. "The most simple case for such a difference of the angle of rotation teaches us, if only in the first instance a spot with a penumbra is present, that a division takes place, which results in the appearance of two separate spots. Such spots regularly move away from one another, each having a separate penumbra. The observations furnish examples which show that the distance of the spots for many days continually increases, and that the angle of rotation of the preceding spot is very considerably greater than that of the following one." The observations included in this volume contain examples of these in great number.

W. J. L.

PHYSICS AND ENGINEERING AT THE McGILL UNIVERSITY, MONTREAL.

So long ago as 1855, Sir William Dawson pointed out the importance to the McGill University of a department of practical science. But though some attempt was made to carry out the suggestion, little success was obtained until 1878, when the department was constituted a Faculty of Applied Science, with Prof. H. T. Bovey as Dean. The Faculty passed through many vicissitudes, but it was placed on a firm basis at the beginning of last year, by the opening of well-furnished workshops and laboratories equipped with the best and most modern apparatus for scientific investigations in all kinds of engineering and physics. A description of the opening ceremonies has lately been published in a souvenir volume, together with descriptions of the main features of the laboratories. We are indebted to this volume for the following information, and to Dean Bovey for the accompanying illustrations.

The McDonald Engineering Building, erected and equipped through the munificence of Mr. W. C. McDonald, one of the Governors of the University, is a fine structure containing laboratories for all branches of engineering work. The Physics Building owes its existence to the generosity of the same donor. It has been designed for the teaching and study of physics (including mechanics) with special regard to (1) its intrinsic importance as an integral part of a liberal education in the Faculty of Arts; (2) its essential necessity as a study preliminary to the courses of engineering, mining, and practical chemistry in the Faculty of Applied Science, and (3) the prosecution of scientific research. The completeness and liberality with which all the necessary plant has been put into these buildings may be judged from the accompanying illustrations and brief descriptions. It will astonish the various authorities who have similar technical institutes under their control in this country, to know that the cost of the equipment alone of the two buildings came to very nearly one hundred thousand pounds sterling! Compare this princely generosity with the fact that only twenty-three thousand pounds were asked for to erect and equip the Engineering Laboratory of the University of Cambridge. The exact amount of Mr. McDonald's benefactions has not been told, but they are certainly nearer seven than six figures. Everything, in fact, required in the pursuit of physical and engineering study has been lavishly provided. Few occupiers of chairs of Physics here are in the fortunate position of Prof. Cox. He was instructed to spare no expense in obtaining everything required to carry on work in experimental physics. "From first to last," he says, "whether it was a question of part of the buildings or of the equipment, I have heard no other language from Mr. McDonald than 'Let us have everything of the best, with a definite aim for everything, but always the best.'"

The Thermodynamic Laboratory (Fig. 1), in which heat engines are studied, has a very notable equipment.

The great feature of interest is a four-cylinder steam engine arranged double tandem fashion, and intended for use in a large number of totally different ways. This machine, designed by Messrs. Schonheyder and Druitt Halpin, of London, under the general direction of Prof. Carus-Wilson, of McGill College, was manufactured by Messrs. Yates and Thom, Blackburn.

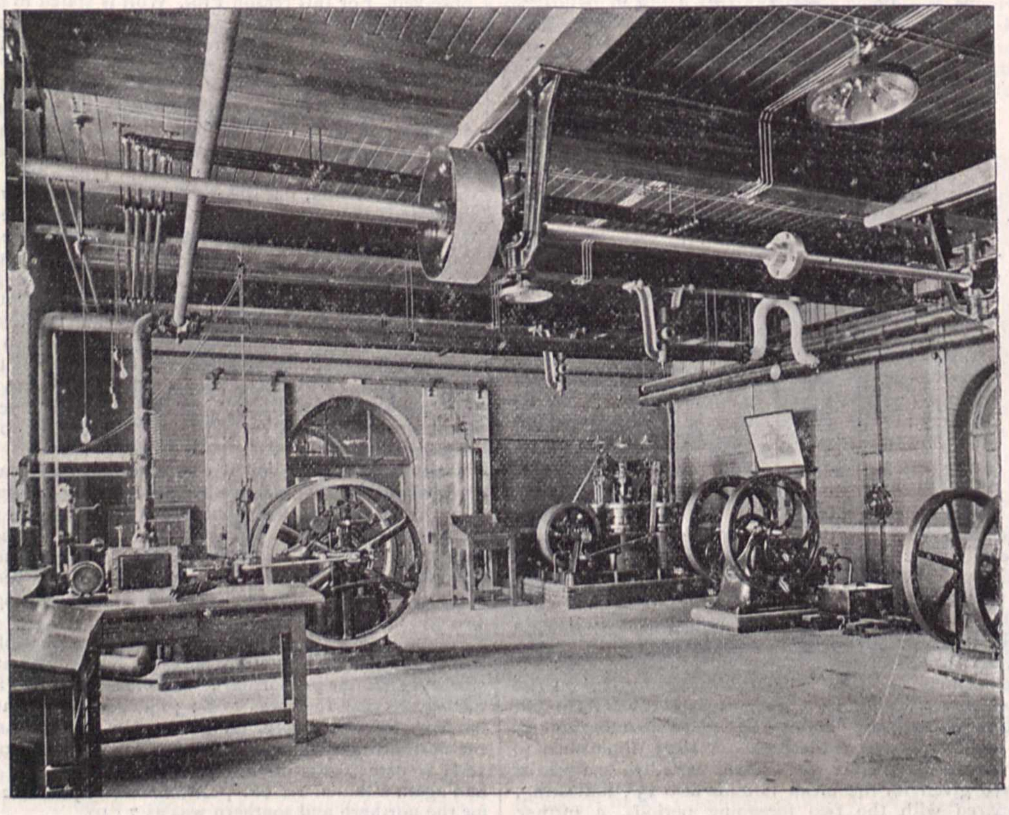


FIG. 1.—Thermodynamic Laboratory.

The engine may be described as a double tandem inverted direct acting quadruple expansion engine, to work at 200 lbs. pressure on the gauge, developing eighty horse-power at about 150 revolutions. The two engines may be uncoupled from each other, and run at different rates of speed on the plan proposed by Mr. John I. Thornycroft, and already carried out on the triple expansion engines at the Owens College, Manchester; and in this way the advantages of variation of relative cylinder volume are to some extent obtained.

The measurement of the power delivered to the brakes is made by means of hydraulic brakes of the types designed by the late R. E. Froude, and improved by Prof. Osborne Reynolds.

The steam pipes about the cylinders are so arranged that the engines may run either quadruple, triple, double, or single expansion. And as the pipes are led both to condenser and atmosphere, all these types may be tried either condensing or non-condensing.

In fact, a complete balance-sheet of the heat supplied, used, and rejected by the engines can be made, and the materials for the study of cylinder condensation by Hirn's analysis are easily obtained.

Several other engines and boilers are available for experimental purposes.

The Third-year Laboratory contains apparatus for the demonstration of the properties of the permanent gases and of steam; and a complete set of the most modern types of pyrometers and thermometers, gauges, mercury columns, planimeters, calorimeters, render possible investigation of many problems of importance to the engineering world.

In the third year, students of thermodynamics are taught the principles of the science by direct experiment; and original research is encouraged during the summer under the direction of the professor.

for many hours. The instrumental equipment consists of comparators, dividing engines; a portable Bessel's reversible pendulum, for the determination of gravity; an astronomical clock, break-circuit chronometer and chronograph; level triers, end-measuring gauges, and minor instruments.

The equipment of geodetic and surveying instruments for the use of students consists of transits and transit theodolites of various forms, levels of the Dumpy Wye and precision types, sextants for marine sounding and land work, plane tables of English and American forms, surveyors and prismatic compasses, current meters, an altazimuth for triangulation work, a zenith telescope, astronomical transits.

There are also hand levels, chains, steel bands, tapes, barometers, pedometers, and other minor instruments required for geodetic work.

The Mathematical Laboratory (Fig. 3) is liberally supplied with apparatus with which the student learns to make measurements of time, mass, distance, acceleration, and other quantities dealt with in the lectures, as well as to verify the fundamental

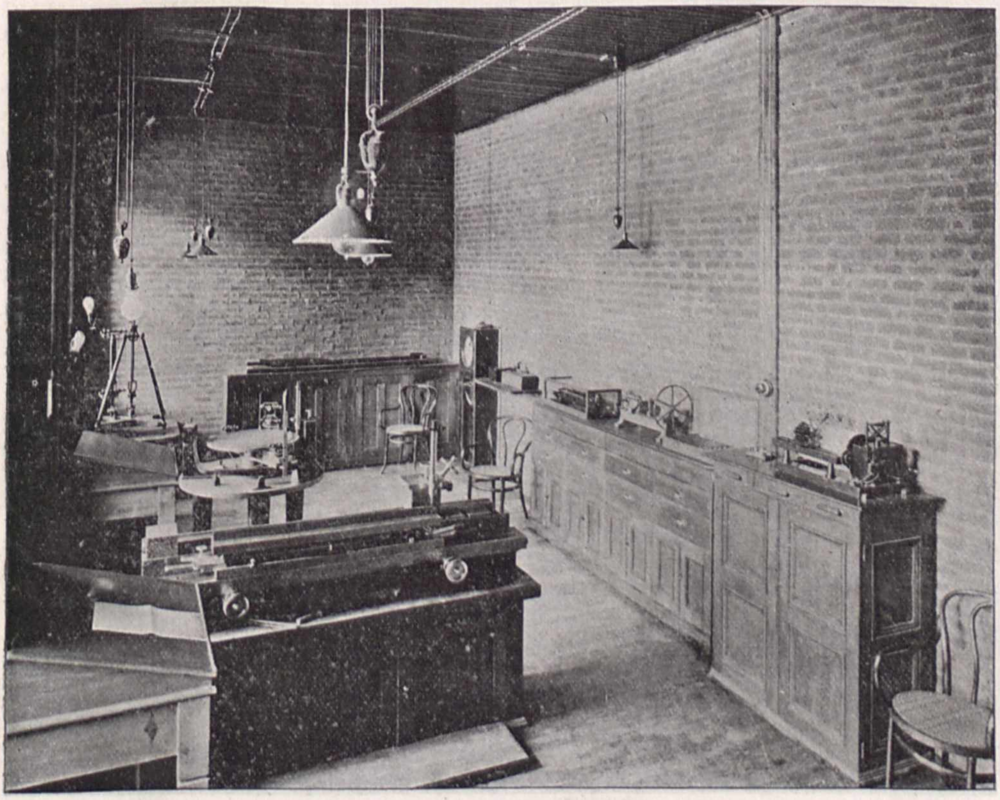


FIG. 2.—Geodetic Laboratory.

In the fourth year, engine boiler and fuel testing is largely worked at; and the higher parts of the subject are explained by reference to the results obtained from the indicator card, as measured and examined for moisture and heat exchange. The gas and hot-air engines are tested again and again, and the effect of the different factors which modify results pointed out by careful observation.

The Geodetic Laboratory (Fig. 2) is primarily designed for the investigation of apparatus used in geodetic and surveying operations; it also affords the means of producing standards of length and of graduating circles.

The laboratory is double-walled, and the inner wall, which is of brick, contains an air space. In the basement there is an air chamber, from which hot or cold air may be supplied to the work-room by a system of pipes. The air circulation is maintained by a fan which is driven by an electro-motor at any required speed. When the desired temperature is reached all openings are closed, and a practically uniform temperature held

laws of mechanics and to investigate various mathematical and dynamical constants. Special attention is directed to the general principles underlying the ordinary instruments of precision which are used in physics, the simpler forms of these instruments being put into the hands of the student at an early period in his course. The experiments are in almost all cases quantitative, and the learner is encouraged to attain the greatest possible precision which the nature of the experiment and the instruments available admit.

The Electrical Engineering Laboratories are under the care of Prof. C. A. Carus-Wilson. They consist of the magnetic laboratory, the electrical laboratory, the dynamo room and the photometer room.

The equipment in the magnetic laboratory comprises a ballistic galvanometer designed for use in a variable magnetic field (this can be connected with any apparatus in this room or in the dynamo room); a calibrating coil for the galvanometer, two magnetic yokes, a solenoid and spring balance for traction experiments up to one hundred pounds, fitted with search coil for ballistic tests; Ewing's magnetic curve tracer; round and rectangular bobbins for experiments in self-induction; a secohmmeter, telephones, rheostats, &c., and a set of secondary cells.

The electrical laboratory is situated over the dynamo room. Slate slabs are let into the wall on three sides of the room, and stout wooden tables placed down the centre. Current is supplied to all parts from the dynamo room. The apparatus here comprises a Thomson galvanometer, three Kelvin electrostatic voltmeters, two Siemens dynamo-meters, four d'Arsonval galvanometers, seven Weston ammeters and seven Weston voltmeters of different ranges, two Weston alternating wattmeters, two Kelvin balances, one of which is specially arranged for testing transformers; two Cardew voltmeters, several other ammeters and voltmeters of different types, standard cells, resistance boxes, rheostats, &c. All tests of transformers are carried on in this laboratory, the current being brought up from the dynamo room below.

dynamo, a 7 k.w. Fort Wayne dynamo, a 5 k.w. Brush arc light dynamo, a 7 k.w. Victoria Brush motor generator, a 15 k.w. Thomson-Houston incandescent dynamo, a 5 horse-power Crocker-Wheeler motor, and several smaller motors of different types; also a 12 k.w. Mordey alternator specially made for this laboratory (the armature coils can be moved through any angle, and two or three currents of any phase difference thus obtained). There are in the building at present eight motors driving lathes, fans, &c., besides a 10 horse-power electric elevator. The dynamo room also contains several transformers, arc lamps, &c., and a set of five enamel rheostats, each of which can be made to carry from 1 to 50 amperes on 100 volt circuit.

The photometer room is furnished with a Bunsen photometer and a Methven standard, and is specially arranged for testing incandescent lamps.

These four laboratories are supplemented by an *Electrical Workshop* containing a fine lathe, by the American Machine Tool Company, driven by an electric motor.

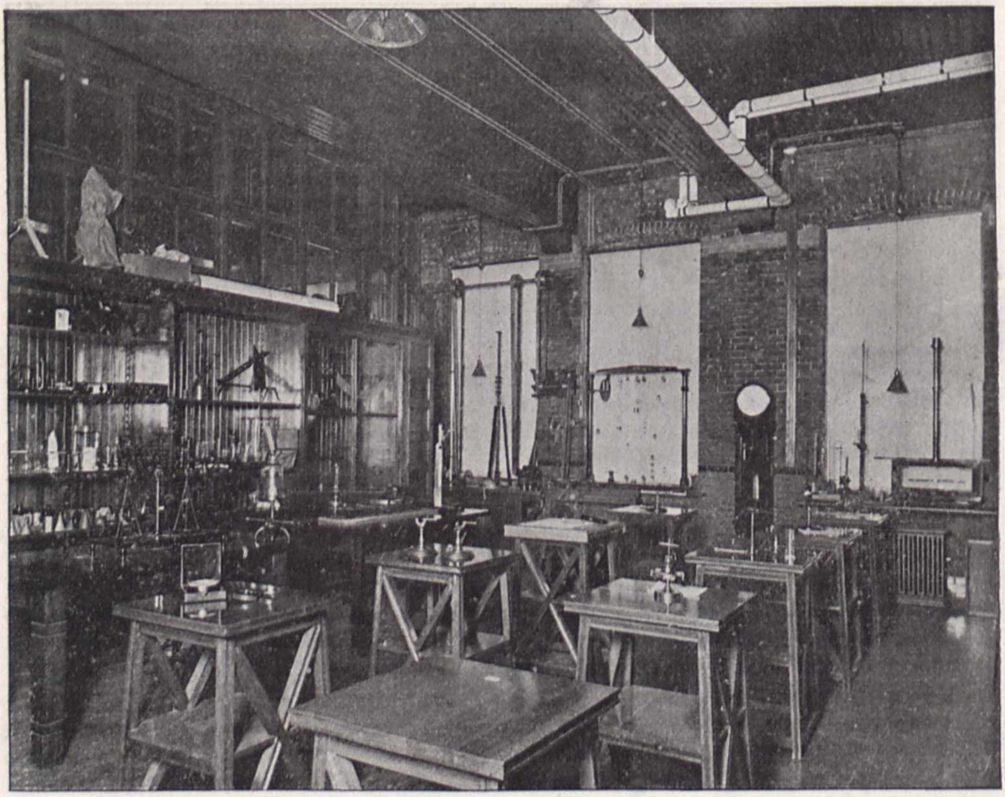


FIG. 3.—Mathematical Laboratory.

The dynamo room is on the ground floor. In one half of the room are placed the lighting, in the other the experimental dynamos. The *Lighting Dynamos* consist of a Siemens dynamo and an Edison-Hopkinson dynamo, each of 30 kilowatts output at 105 volts, and each driven by a 60 horse-power Willans engine. The building is wired on the three-wire system, but can be run by either one of the dynamos when the load is light, or by a set of secondary cells of 800 ampere hours' capacity placed in another room. The lighting switch-board was made in the electrical workshop, and is fitted with Weston station ammeters and voltmeters. The *Experimental Dynamos* are driven off a main shaft either by a 90 horse-power MacIntosh and Seymour engine, or by a 25 k.w. Edison motor, as is most convenient. The main shaft is provided with ten magnetic clutch pulleys of 20 horse-power each, designed and fitted at the college, and with one magnetic clutch-coupling for 90 horse-power; the dynamos comprise two 12 k.w. Edison dynamos, a 7 k.w. Victoria Brush dynamo, a 6 k.w. Thomson-Houston arc light

The work in the Electrical Engineering Laboratories is commenced in the second term of the third year. By that time the students have gained a fair general acquaintance with electricity in the physical laboratory. They then begin a series of experiments on electricity and magnetism, using methods and instruments in ordinary practical use, confining their attention, however, to principles and not to their practical application. This term's work is preparatory to that of the fourth year, when students study the practical application of these principles in the dynamo room. Here they make experiments on electrical machinery of all kinds, and carry out tests of dynamos, transformers, motors, &c., under practical working conditions. They can also see a typical lighting station at work, and become familiar with the best practice and design in all branches of electrical engineering.

The practical instruction in the workshops is solely designed to give the student some knowledge of the nature of the materials of construction, to familiarise him with the more important hand and machine tools, and to give him some manual skill in the use of the same. For this purpose, the student, during a specified number of hours per week, works in the shops under the direct superintendence of the Professor of Mechanical Engineering, aided by skilled mechanics. The courses commence with graded exercises, and gradually lead up to the making of joints, members of structures, frames, &c., finally concluding in the iron-working department with the manufacture of tools, parts of machines, and, if possible, with the building of complete machines.

The machine shop and engine room (Fig. 4), an extremely good equipment, including twelve metal lathes for the special use of students, one large centre lathe, planing, shaping, universal milling, drilling and tapping machines, and all necessary centering and grinding machines. The shop, which is also used for fitting, contains seventeen vices and a very complete assortment of tools. All the machinery consists of types selected from the best manufacturers in England and America.

The hydraulic laboratory contains a tank twenty-eight by five by five feet square, perfectly flush on the inside, and specially designed for investigations as to the action of water under low pressures. The tank is provided with specially designed valves and gauges, which do not interfere in the slightest degree with the stream-line flow, and by means of which variations in pressure in different horizontal sections and under different conditions of flow, can be observed with accuracy. The tank has also fixed to it a recording hydraulic gauge, which has been designed to make one, two, four, eight, or twenty-four revolutions in a specified time. The tank discharges into a water-course about forty feet long and five feet wide. This course may be divided up into one, two, or more compartments, each compartment being carefully calibrated so that the amount of the discharge can be easily estimated. At the end of the course, provision is made for inserting weirs of various forms and dimensions. Over these weirs the water flows into large measuring tanks, which have been carefully calibrated, and each of which has a capacity of about 250 cubic feet. The volume by weight of water in each of these, or in all the tanks, may be observed at a glance by means of an indicator on the wall of the laboratory. Experimental work under high pressures up to 150 lbs. per square inch is rendered possible by a connection with the high-level reservoir of the city. By means of a stand-pipe with special fittings for pipes, nozzles, valves, &c., investigations can be made under any pressure from zero up to the maximum. Any desired head may be kept constant by means of a water-pressure regulator, designed for this laboratory. Pipes from six inches in diameter downwards, can also be led from this stand-pipe for a distance of about sixty feet, so that experiments on the frictional resistance to the flow of water in pipes can be carried out under varying pressures. Another special feature of this laboratory is an impact machine, designed by Prof. Bovey, for measuring the power and investigating the efficiency of water-jets in combination with buckets of different forms and sizes. The laboratory is also to have a set of pumps specially designed for experimental work and research. These pumps are to be adapted to work under all pressures up to 120 lbs. per square inch, and at all speeds up to the highes found practicable, with valves of the best kind and proportions. The equipment of the laboratory also includes a Venturi water-meter, water-meters of other kinds, gauges and gauge-testers, and in fact all the apparatus necessary for the scientific investigation of the properties of water and water-meters, and all kinds of hydraulic apparatus.

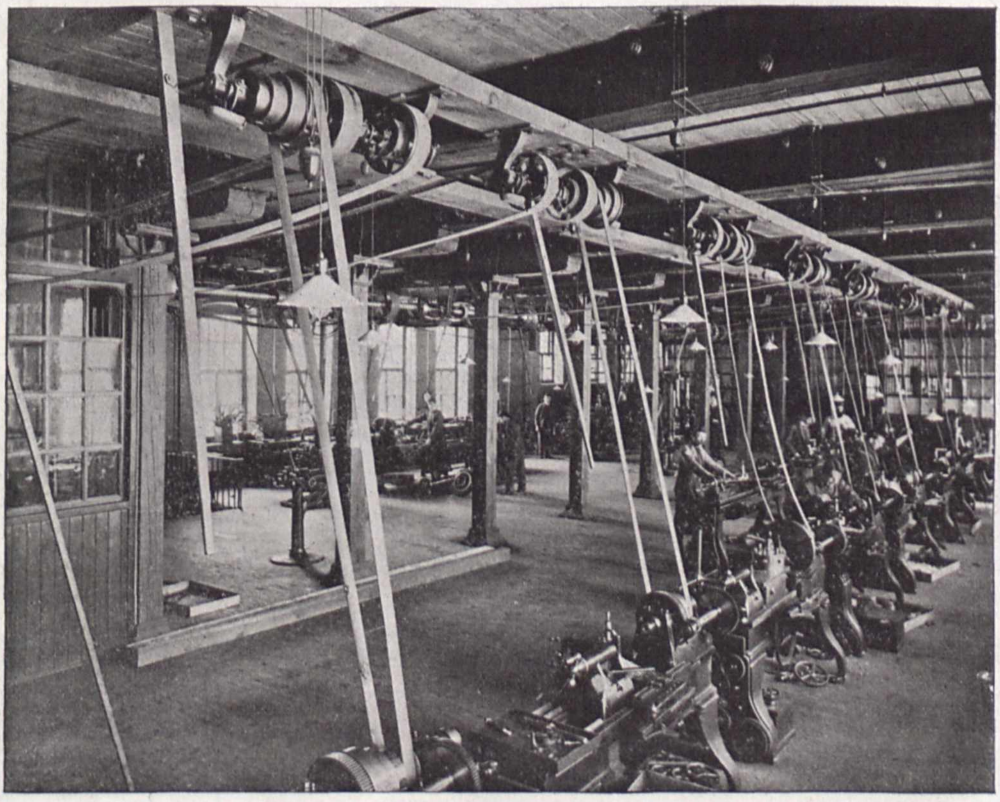


FIG. 4.—Machine Shop.

The main apparatus in the testing laboratories (Fig. 5) consists of a 75-ton Emery testing machine, with a capacity for tension specimens up to 66 in. in length, for compression specimens up to 85 in. in length, and for transverse tests up to 60 in. between bearings; a 100-ton Wicksteed testing machine (Fig. 6), with a capacity for tension specimens up to 72 in., for compression specimens up to 48 in. in length by 10 in. square; an Unwin testing machine for torsional, transverse, and tensile testing; an angle cathetometer (this instrument was specially designed and elaborated for the testing laboratory by Messrs. Nalder Bros., under the direction of Prof. Bovey, to enable

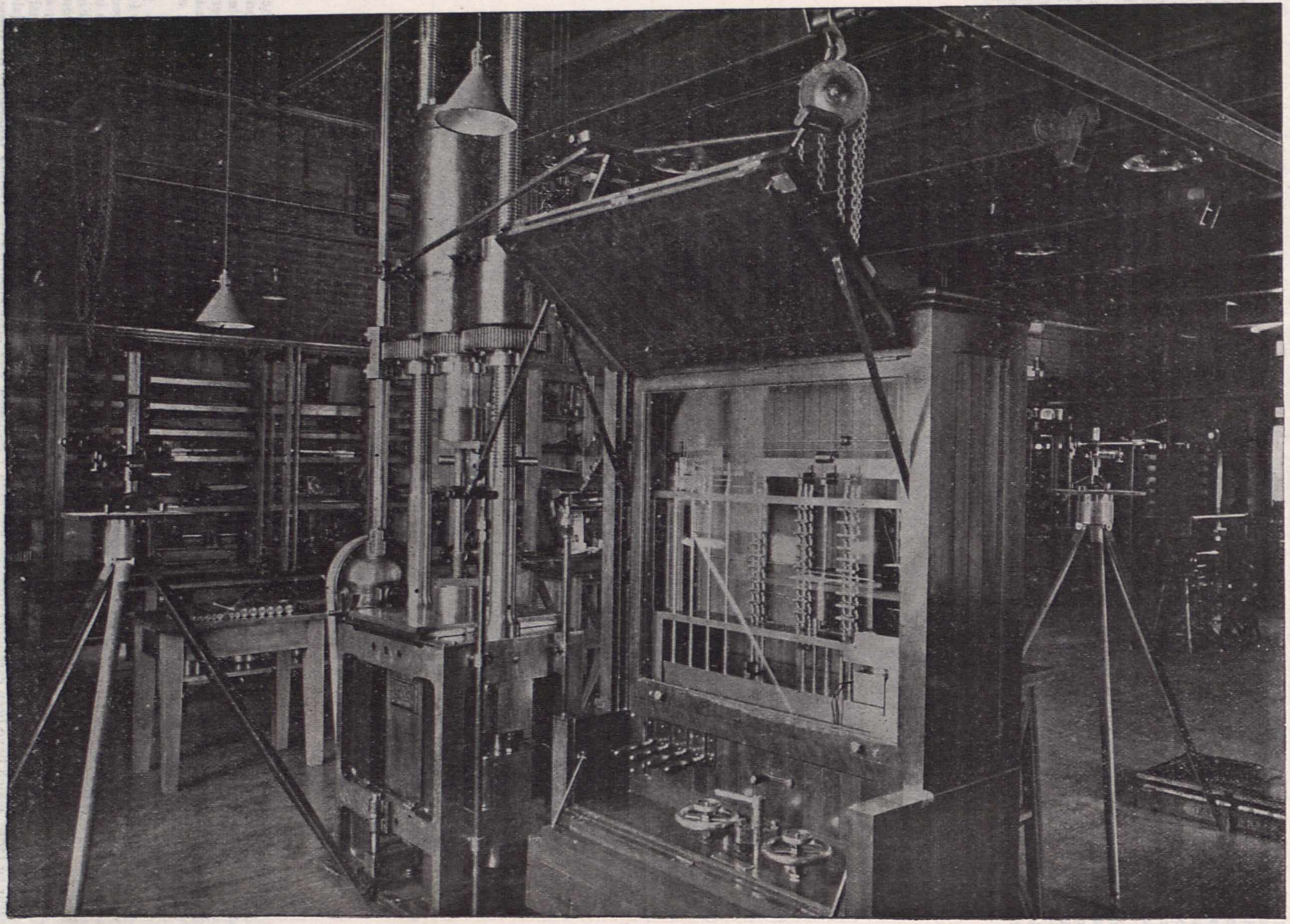


Fig. 5.—Testing Laboratory.

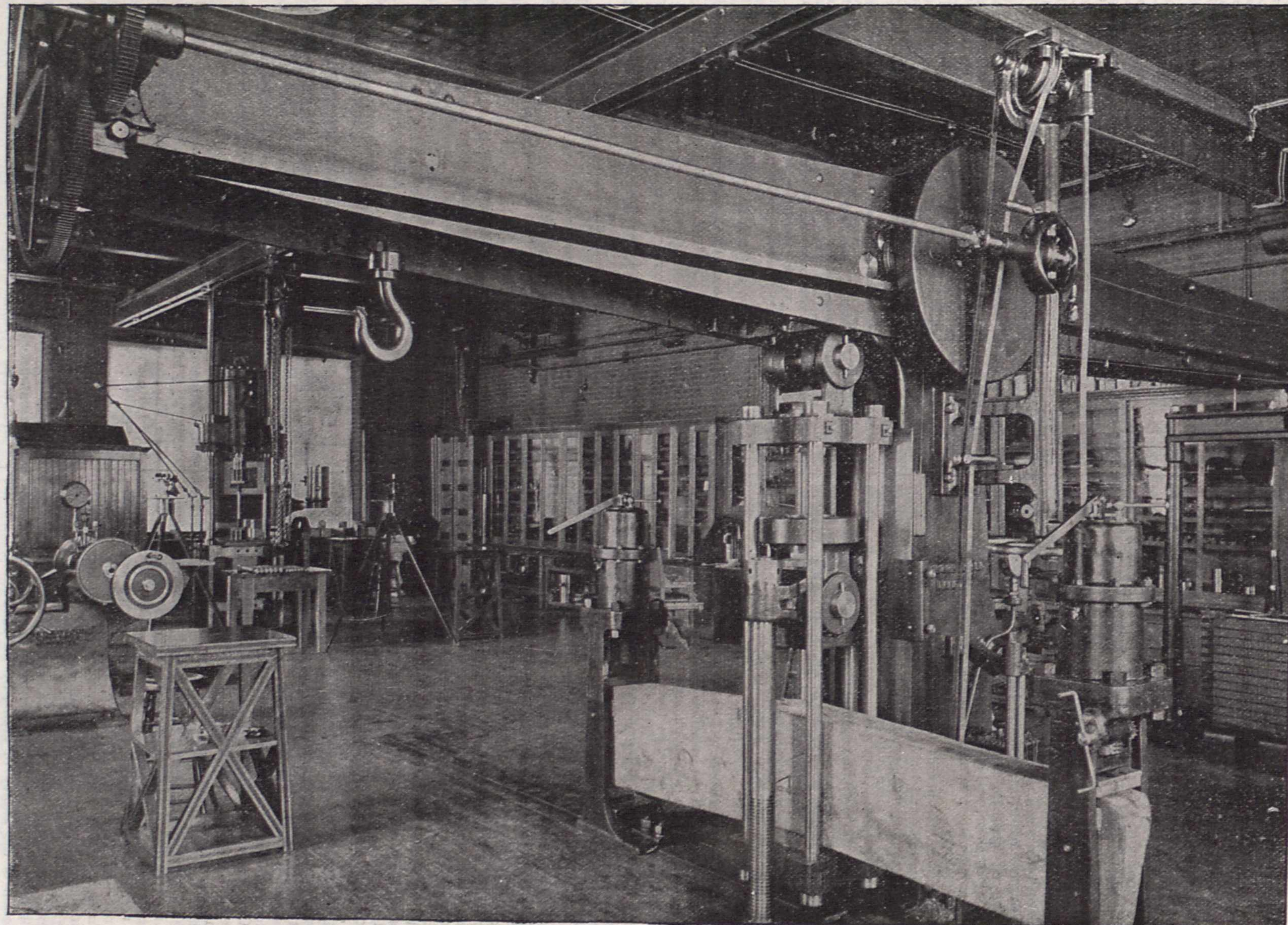


Fig. 6.—Wicksteed Testing Machine.

accurate measurements to be made in connection with the use of horizontal types of torsion testing machines, and also to measure any deflections of a pointer moving about a horizontal axis, through an angle not exceeding 180°); a cathetometer, specially designed for the testing laboratory.

An impact machine is being constructed, fitted with revolving drum, tuning-fork, &c., for recording deflections under rapidly repeated blows. With the aid of this apparatus valuable results may be expected from tests carried out upon materials subjected to repeated stresses.

In the laboratory there are also an Oertling bullion balance with a capacity up to 125 lbs. and down to 1/100 of a grain, and standard weights up to 100 lbs.; a Muir lathe, a shaping machine, and a grinding machine are provided, so that all the apparatus required for preparing the specimens for testing is at hand.

In addition to the above, the laboratories are supplied with numerous other small pieces of apparatus, amongst which may be mentioned Whitworth's measuring machine for measuring a variation of one-hundred-thousandth of an inch, Sweet's measuring machine, and a very complete and elaborate collection of micrometers, vernier calipers, caliper squares, depth gauges, rules, &c.

Our space will not permit us to give an adequate description of the laboratories and lecture-rooms which the McGill University owes to the benefactions of Mr. McDonald and Mr. Thomas Workman, and the mere enumeration of the experimental apparatus contained in them will raise a spirit of envy in the minds of the many workers whose expenditure on scientific instruments is curtailed within very narrow limits. Certain it is that these magnificent donations have provided Montreal with a school of practical science unsurpassed in its facilities for learning.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 24.—M. Lœwy in the chair.—Geodesy and its relations with geology, by M. H. Faye. Gravity has a greater numerical value in islands than in the midst of continents, as the constant is determined by pendulum observations; this is probably due to the more rapid cooling of the crust of the earth beneath extensive seas, as evidenced by the low temperature of water (1° or 2°) at depths at which the temperature is about 133° in land. The greater average density owing to the lower temperature accounts for the higher value of the constant at sea, notwithstanding the replacement of so much solid matter by the specifically lighter water. The author then draws attention to the need of aid from geologists in the further elucidation of the reasons for variations in the constant of gravity.—Truffles (Domalan) from Smyrna, by M. A. Chatin.—M. A. Pomel accompanies a copy of his "Monographie des Bœufs-Taureaux fossiles des terrains quaternaires de l'Algérie" by a brief note on its contents.—Experimental researches on the influence of low temperatures on the phenomena of phosphorescence, by M. Raoul Pictet. Substances showing strong phosphorescence after exposure to sunlight entirely lose this property on strongly cooling (say to −100°), but regain their power on being allowed to approach the ordinary temperature in the dark without further exposure to light. The time during which this *potential luminosity* may be retained, at temperatures such that most of the energy of heat vibrations is abstracted, is now being investigated.—Observations of the sun, made at Lyons Observatory with the Brünner equatorial, during the second quarter of 1894, by M. J. Guillaume. The distribution of spots and faculæ during April, May, and June is given in tabular form.—On the rotation of solar spots, by M. Flammarion. The observed rotations of spots on themselves in several cases are all in the same sense from south through west to north, and amount in one case to 77° in three days, in another to 152° in four days, and in a third case the rotation reaches 34° in two days. This law of rotation is not, however, applicable to cases where segmentation occurs.—On the theory of the Wimshurst machine, by P. V. Schaffers. It is shown that a small modification of the Wimshurst machine enables its efficiency to be doubled, and the reasons leading to this modification are discussed.—On the coexistence, in the same host, of a monosporous coccidian and a polysporous coccidian, by M. Alphonse Labbé.—On the function of the kidney in Helix, by M. L. Cuénot.—On the alimentation of two commensal organisms (*Nereilepas* and *Pinnotheres*), by M. Henri Coupin.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Shilling Arithmetic: J. Hamblin Smith (Longmans).—Memorials of Old Whitby: Rev. Canon Atkinson (Macmillan).—Timber and Timber-Trees: late T. Laslett, 2nd edition (Macmillan).—A Text-book of Pathology: Prof. D. J. Hamilton, Vol. 2 (Macmillan)—An Introductory Account of certain Modern Ideas and Methods in Plane Analytical Geometry: Dr. C. A. Scott (Macmillan).—General Report on the Operations of the Survey of India Department during 1892-93 (Calcutta).—Apparitions and Thought-Transference: F. Podmore (Scott).—The Senile Heart: Dr. G. W. Balfour (Black).—A Text-Book of Statics: W. Briggs and G. H. Bryan (Clive).—A Text-Book of Dynamics: W. Briggs and G. H. Bryan (Clive).—Régularisation des Moteurs des Machines Électriques: P. Minel (Paris, Gauthier-Villars).—Fortification: E. Hennebert (Paris, Gauthier-Villars).—Durham College of Science Calendar, Session 1894-95 (Reid).—Rain-making and Sunshine: J. Collinson (Sonnenschein).—Spiritual Law in the Natural World: J. T. Thomas (Longmans).—Merchant Venturers' Technical College, Calendar, Ninth Session, 1894-95 (Bristol).—La Géographie Littorale: J. Girard (Paris, Société d'Éditions Scientifiques).—Badminton Library—Archery: C. J. Longman and Colonel H. Walrond (Longmans).—Lithogenesis der Gegenwart, Dritter Theil; Einleitung in die Geologie als Historische Wissenschaft: Prof. J. Walther (Jena, Fischer).—Lehrbuch der Vergleichenden Anatomie: Vierte Abthg. Vergleichende Anatomie der Echinodermen und Enteropneusten: Dr. A. Lang (Jena, Fischer).—Ways and Works in India: G. W. MacGeorge (Constable).—The Theory of Sound: Lord Rayleigh, Vol. 1, 2nd edition (Macmillan).—Tenth and Eleventh Annual Reports of the Bureau of Ethnology to the Secretary of the Smithsonian Institution (Washington).—The Nests and Eggs of Non-Indigenous British Birds: C. Dixon (Chapman).—Astronomie Sferica: Prof. Porro (Roma, Società Editrice Dante Alighieri).—The New Technical Educator, Vol. iv. (Cassell).—Nomenclator Coleopterologicus: S. Schenkling (Frankfurt a/m, Bechhold).—New South Wales, Report of the Minister of Public Instruction for the Year 1893 (Sydney, Potter).

PAMPHLETS.—Thesis for the Degree of Doctor of Science of Edinburgh University, on the Relative Efficiency of certain Filters for Removing Micro-organisms from Water: Surgeon-Major H. H. Johnston (Edinburgh, Banks).—Report on the Relation between Malarial Fever among Her Majesty's White Troops at Port Louis, Mauritius, and the Meteorological Elements of Temperature, Rainfall, and Relative Humidity for the Year 1889: Surgeon-Major H. H. Johnston (Edinburgh, Banks).

SERIALS.—Royal Natural History, Vol. 2, Part 11 (Warne).—Zeitschrift für Physikalische Chemie, xv. Band, 1 Heft (Leipzig, Engelmann).—Timehri, June (Stanford).—Schriften der Naturforschenden Gesellschaft in Danzig, Neue Folge. Achten Bandes Drittes und Viertes Heft (Danzig).—Sunday Magazine, October (Isbister).—Good Words, October (Isbister).—Records of the Geological Survey of India, Vol. xxvii. Part 3 (Calcutta).—Popular Astronomy, September (Wesley).

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