THURSDAY, OCTOBER 31, 1889.

"OXFORD AND ITS PROFESSORS."

A TRENCHANT article in the last number of the *Edinburgh Review* arraigns and passes judgment on the University of "Oxford and its Professors." The evidence clearly establishes the facts that the lectures of the great majority of the Professors are but poorly attended, and that, in spite of the efforts of two Commissions, the relations between the University and the Colleges, regarded as allied educational institutions, are not satisfactory. On the causes of this unhappy state of things we do not desire to dwell, but, although agreeing on many points with the author of the article, we must protest strongly against one of the remedies which he suggests.

"Why," he asks, "should not the Universities recognize the principle of division of labour? . . . Why, for instance, should not Cambridge provide thoroughly for the teaching of natural science; and Oxford as thoroughly for that of theology? . . Let the Universities abandon individualism and accept individuality. Let one group of allied subjects be studied in Cxford; another at Cambridge."

It is true that the Reviewer thinks that "a University ought to provide a liberal education, competent to form the basis of that technical training which is special to every trade and profession," but he contends that "beyond this general course, the minutely differentiated special studies into which human knowledge is now necessarily distributed must be recognized and ordered."

We are convinced that an attempt of this sort to confine the special studies of each University to particular lines would do infinite harm. It is not only the students, but the teachers, who are benefited by mingling with others who are their intellectual equals, but whose intellectual activities are put forth in other directions.

It is easy to say that London is within an hour and a half of Oxford or Cambridge, and that London society will widen views which might otherwise contract, and prune down eccentricities which might become serious defects. It is not, however, true, and it is not likely to become true, that the average teacher in a University has society of this sort open to him in early life. More and more frequently—to their honour be it said—lads who begin in the elementary school fight their way to University distinction. Others who start from a position of greater social advantage move "at home" in circles in which literary or scientific ability is rare, and in which they are much more likely to be spoiled by indiscriminate admiration than restrained by judicious criticism.

For a large number of young Fellows of Colleges, the High Table and the Common Room furnish, during the most impressionable years of life, the highest intellectual and social society to which they can attain; and many of those who travel beyond these limits extend the bounds of their acquaintance chiefly among those who are interested in the same special studies as themselves.

It would therefore work terrible mischief if the gulf between specialists were widened by driving them into different Universities. Oxford, we may be sure, would fight to the death against being converted into a mere school of theology. It is said that one of its Colleges some years ago refused an endowment of many thousands which was fettered with the condition that it should benefit only members of a particular Church; and in this temper the suggestions of the Reviewer would be met.

Surely no man who wished well either to the Universities, or to religion, or to science, would desire to see future curates relegated in a body to the Isis, and would-be demonstrators to the Cam; or would mould a Common Room on the pattern of a Clergy House, while a Combination Room was fashioned into a likeness of the Secretarium of the British Association.

Nor do we adopt this view merely on the ground that it is well that students of other branches of knowledge should be leavened by mingling with those who cultivate science. No critic is so unsparing, so useful, and so inoffensive as an intimate friend, and scientific men need criticism as much as others. A hint that, however valuable the scientific results of a treatise may be, they are announced in execrable English, can be conveyed by a college chum better than by anybody else. The Huxley or Tyndall of the future will sometimes be none the worse for the reminder that his predecessors, if they popularized science, did not vulgarize it, and that scientific papers which possibly contain useful additions to knowledge are certainly literature, and, as such, must be tried by the ordinary canons. In short, it is on behalf of the younger scientific men that we claim that those among them who study in our Universities shall not be deprived of the advantage of intimate relations with fellow-students of their own standing, whose aims in life, and modes of thought, are other than theirs.

The argument from economy is sufficiently met by the above considerations, but it is absurd to contend that there is not room for two great schools of science in the Universities, if proper means are taken to fill them.

In every provincial town, Colleges are springing up which are far better equipped than were the Universities themselves some twenty years ago, and the number of their students steadily increases. In Cambridge, the scientific lecture-rooms and laboratories are full to overflowing; and we cannot but believe that, if Oxford is less successful, the comparative failure is due either to temporary causes, or to some defect of organization which could be discovered and remedied.

According to the Reviewer, the relations between the Professoriate and the Colleges are not harmonious, and, if this be so, natural science is probably more injuriously affected than any other branch of study. Centralization, harmful in many cases, is essential in the teaching of a subject which at present attracts a small number of very advanced students, while the machinery for the instruction of elementary students must necessarily be expensive. That it can be attained without trenching on the legitimate privileges of the Colleges is proved by the fact that, in spite of the existence of the Collegiate system, Cambridge has become a great school of science.

SUBJECTS OF SOCIAL WELFARE.

Subjects of Social Welfare. By the Right Hon. Sir Lyon Playfair, K.C.B., M.P., LL.D., Ph.D., F.R.S. (London: Cassell, 1889.)

IN this volume Sir Lyon Playfair has collected a series of his essays, speeches, and lectures, composed or delivered during the last half-century. The volume is divided into three parts, the first dealing with questions relating to public health, the second with various economic problems, and the third (of course) with educational topics. Though most of the essays are more or less scientific in character and mode of treatment, only one is purely scientific, viz. that on "Sleep and some of its Concomitant Phenomena," which contains, with a few alterations, the substance of a lecture delivered before the Royal Institution in 1846.

The whole forms a volume which, if it will add nothing to the great reputation of the author, is eminently readable, and exhibits his usual power of apt illustration and dexterous handling of masses of facts. It is not, indeed, a book which many will read from cover to cover, for, as is natural when we consider the conditions under which its contents were originally produced, there is a considerable amount of repetition both in the subjects and in the mode of treatment. But readers in search of trenchant arguments and pointed illustrations on such debated questions as vivisection and vaccination will find both in the lucid and pithy discourses devoted to these subjects by Sir Lyon Playfair; and there is a great variety of interesting economic facts drawn both from Europe and America in the second part of the volume, which deals with industrial wealth. We cannot, however, candidly say that we regard the second section of the book as satisfactory. Much of it was originally intented to serve a definite and temporary purpose—to confute an adversary or to reassure wavering adherents of Free Trade—and for such a purpose it was well adapted. It came under the head of what an eminent politician has called the literature which to-day is and to-morrow is (or at least should be) cast into the oven, and its preservation will, we fear, serve no useful end. When, for example, Sir Lyon Playfair declares that, "so far as regards politics, ethics, sculpture, painting, and architecture, the world has advanced little beyond, if it has reached, the position attained by Greece and Rome. These, though they grace, do not now form the foundation of a nation's prosperity. That is formed from the applications of science to industry," he is expressing an opinion which may have been the passing sentiment of a moment, but which he will hardly care to have permanently associated with his name.

One of the weakest of the papers is that on bimetallism. Sir Lyon Playfair does not appear to realize the point of view of the bimetallist economists, who, however unpractical they may be, are not wanting in theoretic knowledge and power of analysis, and who are certainly not in such a state of fog as to the cause and regulator of the values of the precious metals as their critic seems to suppose. Such men as President Walker, whose exposition of the question is not lacking in clearness, certainly never subscribed to the opinion gratuitously thrust upon bimetallists by Sir Lyon Playfair, that the value of gold and silver can be fixed by statute *independently* of the state of demand and supply. But a very brief examination of the subject will make it clear that the establishment by a considerable number of nations of a legal ratio between the values of gold and silver would be a most powerful factor in altering the conditions of demand, by making the two metals alternative for the purpose for which they are most largely used. This automatic action of the "bimetallic bond" would be comparatively insignificant in the case of a single nation surrounded by monometallic countries, because the neighbouring countries would offer such a wide area for the overflow of the dearer metal, which might thus all drain away before matters could readjust themselves; but it would become theoretically very powerful if four or five of the great nations could unite for the establishment of the double currency. The real objection to such a policy arises from the practical difficulty of forming a strong international monetary union, and the physical fact that silver is much heavier and more inconvenient to carry than the equivalent value in gold. These difficulties are very real in practice, but it is useless to suppose that the bimetallic position is turned by an appeal to the action of the Chinese Emperor Wang-Mang, who is said to have proclaimed a legal ratio of value between (*sic*) five shells—in which attempt he very naturally failed.

It is time also that economic writers gave up the vague references to supply and demand as the cause of all things; as though supply and demand were ultimate facts incapable of being further analyzed and explained. "These *laws*," says Sir Lyon Playfair, "are all-powerful, and no statute *law* of one nation or of ten combined nations can prevail against them." (The italics are ours.) Now what is this but a revival of the old confusion between the two meanings of the word "law," which once led a writer in a leading Review to question the use of economic laws unless enforced by the police? In other essays Sir Lyon Playfair declares (with truth) that Protection raises prices and lowers wages. Is not this a case of a statute law "prevailing against," or (as we should put it) modifying, the conditions of supply and demand?

In the same lecture on bimetallism Sir Lyon Playfair told the National Liberal Club that "gold might be stationary in quantity *and value*, while the prices of commodities might fall from causes having no relation to it, and then its appreciation or power of increased purchase would be a contemporaneous fact but not a cause of the depreciation." How can "value" be stationary while "purchasing power" rises? The meaning of the passage is not obscure; but the looseness of phraseology is deplorable in a science in which strictness in the use of terms is so essential. Would Sir Lyon Playfair say that a schoolboy had not gone up in class because it was the fault of his companions that they had gone down?

A far more thoughtful essay is that on the displacement of labour by modern inventions, in spite of the use of such loose phrases as "labour has suffered much less than capital," and the old confusion between changes in the *rate* of profit on capital and the (totally distinct) *amount* of profit reaped by the capitalist. Sir Lyon Playfair was personally acquainted with the three great discoverers, Oersted, Faraday, and Wheatstone, who have revolutionized commerce by their electrical researches; and he views the changes which are taking place in modern industrial conditions from a large and philosophic point of view, seeing in them the inevitable dislocations and friction resulting from a slow and difficult readjustment of industry consequent on new discoveries. To take one case. The discovery of the mode of making madder from coal tar has reduced the importation of natural madder into this country from 22,000,000 pounds in 1872 to 2,000,000 in 1887. What has become of the former madder-growers? To what industry have they betaken themselves? What class of producers have they in turn displaced by so doing? Sir Lyon Playfair does not attempt to follow out such questions as these, bnt his essay suggests them, and it would be well if they received more attention than has hitherto been usual among economists.

There are several articles dealing with various phases of industrial competition. They all expose the fallacies of fair trade, and all lead up to a demand for technical education. Sir Lyon Playfair has here used to advantage the facts collected in his recent visit to America; but when so many sound arguments lay ready to his hand, where was the necessity of resorting to the essentially unsound reasoning that Protection is conclusively shown to have lowered wages because the wages in *some* unprotected trades (carpenters, bakers, and printers) are higher than wages in *some* protected trades (cotton-spinners, weavers, tailors, and machine-makers)?

The third part of the volume deals with questions of education. Here Sir Lyon Playfair is more at home. Long before technical education became a fashionable cry, he had urged its importance upon the public, and he has lived to see in some measure the fruition of his endeavours, of which the speeches and lectures collected in the volume before us form no unimportant share. The subjects treated range from primary education (on which there is a reprint of a very interesting address delivered at a very interesting time, viz. immediately after the passage of Mr. Forster's Act of 1870) to the relations of the Universities to professional education, on which, as might be expected, Sir Lyon Playfair takes a strong and decided line. "Each profession," he says, "has its own foundation of liberal culture. At present the Universities try to build all professions on one uniform foundation, though this is as foolish as it would be to build a palace, a gaol, or an infirmary on a single ground plan common to all. The professions have indicated by their special literary examinations what their several foundations should be; and if the Universities know how to extend their obligations to modern society, they should have little difficulty in again assuring their original purpose of affording a liberal culture to the professions. The Universities would gain in strength and the professions in dignity and in efficiency." This was spoken in 1873, and the last sixteen years have seen a very marked advance on the part of the old Universities in the direction indicated by Sir Lyon Playfair, though many authorities will still disagree with his general conclusion.

An interesting address is inserted on technical education, which, though delivered in 1870, contains matter for thought at the present day, and reminds us how long the British public have taken before awaking (if indeed they can yet be said to be awake) to the importance of doing something as a nation to raise the standard of instruction in the principles of science and art applicable to industries. We could wish, indeed, that Sir Lyon Playfair, who so powerfully calls attention to the need, had given us a little more in the way of positive suggestion; there are parts, too, of the essay which may be taken to encourage the heresy that the province of the technical school is to replace the custom of apprenticeship and take the place of the workshop. We are strongly in favour of the movement for technical education, and we hailed even the Government measure lately passed, halting and inadequate as it is, as being at least a step forward in the right direction. But if it is to be used to encourage the teaching of a smattering of a large number of trades, instead of giving a thorough training in scientific and artistic principles of more widespread application, it may be that it will do more harm than good; and it is time, now that the measure has become law, for the advocates of technical education to make themselves heard with no uncertain voice upon this all important point. Meanwhile, it is no small praise to say, and we say it with truth, that there is no man living to whom the advance of public opinion on the subject of technical education in recent years is so much due as to the author of "Subjects of Social Welfare."

SERVICE CHEMISTRY.

Service Chemistry. By Vivian B. Lewes, Professor of Chemistry, Royal Naval College, Greenwich. (London: Whittingham and Co., 1889.)

IN this book Prof. Lewes treats of chemistry in its relations to the subjects which are of immediate interest and importance to our naval and military services. Although primarily intended for the officers passing through the Royal Naval College, much of the matter of the book has a direct bearing on the work of the soldier. The necessity for such a book is obvious. Of course, as Mr. Lewes is careful to point out, there is but one chemistry, and its principles and theories are the same, no matter how the science is made subservient to the wants and different callings of men. But it is manifestly absurd to suppose that our soldiers and sailors need to be taken over the whole field of chemical science in order to obtain such a knowledge of those principles as will be of use to them in their professions. No doubt, in the interests of knowledge itself no course of instruction can be too extended, but in the case of the officers of both branches of the service there is the practical difficulty of time. The scheme of instruction at our naval and military colleges is so elaborate, and the amount of time allowed for study is, comparatively speaking, so limited, that it is absolutely necessary that the teachers of chemistry in such colleges shall restrict themselves to the treatment of the relations of chemistry to the practical work of the services. Nor will the teachers have cause to complain of any lack of subject-matter for their lectures. Even if the young officer came to his work with a fuller knowledge of the elementary principles and facts of chemical science than is usually furnished to him at school, so that his teacher at college could at once proceed to treat of its technical bearings so far as these have reference to the work of the soldier and sailor, there would still be ample matter for even the most extended course of instruction that would be practically possible. Of this fact Prof. Lewes's book gives ample evidence. The general character of our public-school education, in spite of recommendations of Royal Commissions and British Association Committees, and repeated warnings of men like Huxley and Spencer that the conditions of modern civilization imperatively require a readjustment of the curriculum of our schools, is still such that the teacher has to assume an entire ignorance of even the most elementary facts of physical science. The students at the Royal Naval College are no doubt largely recruited from the public schools. Any well-devised scheme of school instruction ought, one would think, to give them such a knowledge of the rudiments of chemistry as to obviate the necessity for the teacher to spend a considerable fraction of the limited time at his disposal in discussing such matters as nomenclature and notation, formulæ and equations, the simple laws of chemical combination, effects of temperature and pressure on gases, and so on. But Prof. Lewes no doubt, as indeed his book demonstrates, finds it absolutely necessary to deal with these preliminary matters in the outset of his course. Hence the book naturally divides itself into two portions—one, and of course the most important portion, treating of the technical relations of chemistry to the work of the services; and the other treating of such of the general principles of the science as are necessary to an intelligent appreciation of these relations. The latter portion, of course, precedes the former in the actual plan of the book.

It is, however, characteristic of the eminently practical character of the book that Prof. Lewes loses no opportunity of pointing the moral by some reference to a "service" fact. Thus he has occasion to treat of the chemistry of the galvanic battery, and what he has to say about the electro-chemical behaviour of metals leads up to the question of the fouling of ships' bottoms; the possibility of strong galvanic action set up in iron ships causing the destruction of the screw shafting and rudder-posts, &c.; the effect of mooring a copper-bottomed vessel to an iron pier, &c. No officer intelligently following a course of instruction such as this can be blind to the influence which science is capable of exerting on the work of his profession. The sailor whose respect for a fluid which is so useful in navigation is so profound as to forbid him to drink of it, would doubtless have that respect intensified by the account which Prof. Lewes gives of the physical and chemical characters of water, although, possibly, the section on filters and filtering media may have only an abstract interest for him. This chapter, of course, contains nothing but what is the common property of text-books; but it is put together in such a manner as to show the bearing of the facts on the every-day life and work of the sailor. The chapters on Boiler Incrustation and on Ventilation are also capital illustrations of the way in which the service aspects of the matter are dealt with throughout the book. A short account of carbon, its oxides, and simplest hydrides, naturally leads up to a description of the manufacture of coal-gas, the nature of luminous flames, the causes of fire-damp explosions both in the mine and in the holds of vessels; whilst the chapter on fuel is of especial interest, from the manner in which the results obtained by the Commission on the Navy coal, and the reports as to the value of liquid fuels, are summarized and discussed. The methods of calculating the evaporative value of fuel from percentage composition, and the mode in which such calculations are checked by calorimetric determinations, are also described, and their precise value indicated. The subject of Explosives naturally takes up a considerable space. The mode of manufacture of service powders, cocoa powders, amide powder, &c., is fully described and illustrated, and the nature of the chemical changes on firing gunpowder, as determined by Noble and Abel, Lenck, Karolyi, Bunsen, and Schischkoff, is explained in detail. The chapters have indeed been put together with special care, and contain much that has not yet been incorporated with any other text-book, not only as to details of manufacture, composition, and mode of decomposition, but also as regards proving and keeping. This question of the effects of storing in overheated and badly ventilated magazines is extremely important, especially in regard to powders for large ordnance, and the little that is at present known on the subject is stated in the book.

Only such compounds of the metals and non-metals are dealt with as have immediate relation to service questions. In treating of the action of light upon silver salts the author gives a concise account of the more important methods of photography with special reference to dry-plate work; and the book concludes with a chapter on the chemical nature of the more generally used inorganic pigments, and on the causes of corrosion and fouling of ships' bottoms and marine boilers. This constitutes one of the most valuable sections of the work, and embodies the results of much reading and original investigation.

We congratulate Prof. Lewes on having compiled a most useful and eminently practical work. It of course makes no pretensions to be a complete manual of inorganic chemistry, but it seeks to deal in the most direct manner with those matters which are of special interest to the class of readers for which it is specially intended. It is capitally printed, and for an English text-book, unusually well illustrated; indeed, the entire "get up" of the work reflects great credit on the publishers. The book is, on the whole, well up to date, and every care has apparently been taken to verify statements of numbers and constants. The mode of decomposition of potassium chlorate given on p. 66 should, however, be amended in view of the work of Teed, and of Frankland and Dingwall; and the statement as to the action of peroxide of manganese in facilitating the breaking up of the chlorate requires alteration. It may also be pointed out, in view of the passage on p. 70, that oxygen compounds of fluorine *are* known, *e.g.* the oxyfluoride of phosphorus. Chlorine also *has* been solidified, and the statements as to the boiling and melting points of bromine and iodine given on pp. 315, 317, and 320 are conflicting. The figure on p. 379 is hardly a sufficiently accurate representation of a puddling furnace. However, these are but minor blemishes that can readily be rectified in the second edition which we trust may be speedily called for.

WATTS' DICTIONARY OF CHEMISTRY.

Watts' Dictionary of Chemistry. Revised and entirely rewritten, by M. M. Pattison Muir, Fellow of Caius College, Cambridge, and H. Foster Morley, Professor of Chemistry at Queen's College, London. Vol. II. (London: Longmans, Green, and Co., 1889.)

THE appearance of the second volume of the new edition of "Watts' Dictionary" will be welcomed, not only by chemists of every persuasion, but by all who love and work at science. This volume, reaching from

"Chloral" to "Indigo," not only gives descriptions of all important chemical elements and compounds contained between these two heads, but contains short articles on matters of general chemical interest, both of theory and of practice. The editors desire to give their work a truly international character, and we find valuable contributions, not only from eminent English specialists, but from equally competent authorities in Washington, Baltimore, and Sydney; whilst the presence of articles from the pen of a lady—Miss Ida Freund, of Newnham—indicates that scientific research and exposition are no longer to be confined to the hands and heads of the so-called stronger sex.

In turning over the eight hundred pages of this closely but clearly printed volume, one is first struck by the enormous mass of detail with which the editors have had to deal. Not what to print, but what to leave out, is the problem which all writers whose hard fate it is to have to record the present condition of chemical science have to try to solve. So enormous is the number of chemical substances which each day brings forth, so complicated are the questions of theory which their existence raises—questions which therefore vary from day to day and from month to month—that to give a clear and yet complete account of them may indeed be said to "pass the wit of man." Still, this, like other difficult problems, has to be attempted, and upon the way in which the attempt is made depends the success or failure of a work of this kind. Unless the student can gain a clear and correct idea of the present condition of the science as regards the special subject of the article upon which he seeks information, the book is worse than useless. Unless the specialist can find at least some sort of light and leading, and is supplied with references for detail to the work done by his forerunners, the "Dictionary" will be of but poor service to him. I venture, however, to think that, tried by both these standards, the verdict of the public will be that the editors have acquitted themselves well, and that this second quarter of the new chemical "Dictionary" will rank as high as the first already does, and will bear favourable comparison with the older parent volume—now, alas, with its author, numbered with those whose names have for us only an historic interest.

A dictionary merely confined to an enumeration of the names, composition, properties, and constitution of the many thousands of chemical compounds now known, like the classical work of Beilstein—however valuable, nay essential, to the student in the higher terms of the series—is not what the beginner or the general scientific reader or worker needs. He must have access to a book in which both the general and the special problems of the science are discussed with full knowledge of the position of the day. That this necessity has been understood, and carefully provided for, is seen by the list of articles furnished by special contributors, as well as by glancing at those written by the editors themselves. In that on "Chemical Classification," by Mr. Muir, we find an able statement of the case, with the modest introduction that "in the following article nothing more is attempted than to sketch the outlines of the methods by the employment of which a fairly satisfactory scheme of chemical classification may be attained," followed by the well-known definition of scientific classification given by Jevons in his "Principles of Science." The article on "Crystallization," by Mr. Harry Baker, is a model of perspicuity, and, whilst much shorter than the article on the same subject in the former edition, is sufficiently comprehensive for those who wish to gain a knowledge of the principles of this important branch.

Of all the special articles, perhaps that by Prof. J. J. Thomson, of Cambridge, on "Chemical Equilibrium," and that on "Dissociation," by Prof. Threlfall, of Sydney, are the most interesting and important. Both of these articles seem to give a new tone to ordinary chemical life; they introduce the chemist to fresh fields and pastures new. They point to the fact that the stream dividing chemistry from physics has been bridged over, not only at one point but at many, and that certain chemical phenomena which beforetime have been considered as apart and distinct can now be shown to be capable of mathematical treatment, as belonging to the domain of molecular physics.

Whilst, however, in certain directions chemistry is rapidly becoming a branch of physics, there are other chemical phenomena which ally themselves with those classed as biological, and of the most important of these the "Dictionary" gives us an example in an excellent though too short article on "Fermentation and Putrefaction," by Dr. Rideal. Prof. Ira Remsen, of Baltimore, contributes two articles, one on "Equivalency" and one on "Formulæ." In this latter he reminds us of a fact known to but few that the symbolic notation introduced by Dalton in 1808 had been preceded by an attempt, though a less satisfactory one, in the same direction by Hassengratz and Adel in 1787, though we may be sure that of this attempt the Manchester philosopher was in blissful ignorance.

Other special articles, such as those on "Combustion and Flame," by Prof. Thorpe, on "Dextrin," by Mr. O'Sullivan, on "Cinchona Bark," by Mr. David Howard, amongst many others, have only to be mentioned to show the value and interest of the volume, which (in spite of necessary shortcomings, and of occasional unavoidable errors, which some may care to seek for, though I do not) appears to me to be well worthy of the name it bears, of the house which publishes it, and of the science which it expounds, and this is saying a great deal.

H. E. Roscoe.

OUR BOOK SHELF.

Index of Spectra. By (W. Marshall Watts, D.Sc., &c. Revised Edition. Manchester: Abel Heywood and Son, 1889.)

Dr. Watts is to be congratulated upon the completion of his great undertaking—namely, to collect all the existing measurements of laboratory spectra, and arrange them in a manner convenient for reference. Since the last edition of the book was published, seventeen years ago, spectroscopic research has made enormous progress, as a comparison with the new edition will show. This is no doubt partly due to the increased number of workers, and instrumental advances, and to a large extent to the extension of the spectroscopic field into the ultra-violet and infra-red. In the old tables the limits of the spectra were practically 394 and 670, whereas in the new ones the lines range from 204 to 770. Spectroscopy has also advanced in another direction. It was formerly believed that each substance had its own characteristic spectrum, from which there was no departure; but subsequent researches have shown that the spectrum does not entirely depend upon the substance under examination, but also upon the conditions of temperature and pressure. In the old tables, for example, only one spectrum of oxygen was recorded, but now no less than three are given. Hydrogen, again, has now two spectra recorded, and nitrogen three, including Hasselberg's important observations.

The wave-lengths given in Ångström's "Spectre Normal du Soleil," with a few small corrections, are still taken as the standards for reduction. The tables printed in the Reports of the British Association Committee form the basis of the new edition, but there are also many important additions. One new feature is the addition of a column giving oscillation frequencies, in number of waves per centimetre *in vacuo*, which will no doubt be appreciated most by investigators of the molecular origin of spectra. Tables of the spectra of various compounds, such as ammonia, alumina, and other oxides, chlorides, iodides, &c., and water, are also given. The different substances are arranged alphabetically as in the old edition, and at the head of each there are full references to books and memoirs. The introductory matter has also been considerably expanded, and now forms an excellent guide to spectroscopic scales and methods of mapping. The use of a lens to throw an image of the light source on to the slit, a method which has yielded many valuable results, is, however, unfortunately omitted. The book will be heartily welcomed by all who are engaged in spectroscopic work, and no recommendation of ours is necessary.

A Text-book on Steam and Steam-Engines. By Prof. Andrew Jamieson, M.Inst.C.E. (London: Chas. Griffin and Co., 1889.)

WE welcome with pleasure the fifth edition of this work. Few engineering text-books are intelligible to the average student. Many writers, in dealing with even the simplest engine or mechanical contrivance, completely fog the reader's understanding by the undue use of mathematics and abstruse formulæ. The volume before us is the best yet published for use in the engineering classes at our schools and colleges. Prof. Jamieson has treated the subject in a sensible and useful manner; his examples are worked out as simply as possible; and the descriptions throughout the work are those of a practical man who knows his business.

The new edition contains many extensive and important additions both to the text and illustrations. The chapter on locomotives has been considerably enlarged and improved. An express-engine built by Messrs. Dubs and Co., the eminent Glasgow locomotive builders, is taken as an example, and many well-executed scale-drawings are given as illustrations. Even with these additions the chapter does not do justice to this important branch of engineering, and Prof. Jamieson must not overlook the fact that he has many locomotive engineer apprentices attending his Glasgow classes. The few paragraphs on the compound locomotive are decidedly weak. Mr. Webb's compound locomotive "The Experiment" is excellent ancient history, no doubt; but why not describe the more recent Webb compounds, or, better still, the Worsdell and Von Borries two-cylinder compounds, now doing such good work on the North-Eastern and many foreign railways?

N. J. L.

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.*]

An Unusual Geological Sequence.

IN a late expedition to the north-west coast I have come upon evidence of a fact which was quite new to me—namely, that the well-known Cambrian red sandstones of Ross and Sutherland do not always rest upon the Archæan gneiss, but occasionally on dark blue stratified rocks with which the sandstones are perfectly conformable. For many years I have been familiar with the ordinary sequence, according to which the Cambrian or "Torridon" sandstones rest unconformably on the Archæan gneiss with nothing interposed between them. Nowhere in Sutherland, or in Loch Torridon, so far as I have observed, is there any variation in this order, and I have stood on some hills in Sutherland where the Cambrian sandstones are represented by only a few remaining cakes of conglomerate which lie bedded almost horizontally upon highly unconformable gneissic strata. I was therefore much surprised to see in a little creek on the eastern shore of the Island of Rāāsay, a low precipice of the red sandstone terminating in conformable beds of a rock of very dark colour, and with a texture but little crystalline. The sudden and violent change of colour at once attracted my attention, and on landing and obtaining specimens I found there could be no mistake that the Cambrian sandstones here rest upon some older rock totally different in mineral character from the Archæan gneiss, and equally different from themselves.

Pursuing this (to me) discovery, I examined the eastern face of the same island, where its precipices include fine escarpments both of the Secondary and of the older rocks. There, at one point, I found the same unusual sequence beautifully distinct. The sandstones are represented by a bed of strong conglomerate, and this bed rests conformably upon well stratified rocks of a blue, or dark blackish-blue colour, with a fracture far less crystalline than most of our Silurian slates on the mainland of Argyllshire.

Following up the same clue, I found that on the western shores of the Island of Scalpa, these blue rocks underlie in great thickness the red sandstones which form the bulk of the island, and which are exclusively seen by all who approach it from the eastern and northern sides.

I now understand that this fact has been for some time known to Dr. Geikie, and that the officers of the Survey under him have come across it with equal surprise, in certain parts of Ross-shire. But, so far as I know, it has not been published, and is not generally known.

In one specimen which I obtained on Scalpa there are obscure indications of Annelid borings, together with calcareous cavities, which are very suggestive of an organic origin.

If these rocks really belong to the Cambrian series, as this complete conformability would imply, and if they have been wholly removed in all but a few spots, before the Torridon sandstones were laid down, the fact gives one a good deal to think of both as regards the intervals of time which they represent, and as regards the agencies of change which must have been at work.

To what horizon do these blue rocks belong? The Sutherland fossils from Durness are thought to be among the very oldest Silurian forms. Below these come the great white quartzites of the same county. Below them, again, unconformably, come the Torridon sandstones, and lowest of all come these subsequent blue beds—not at all metamorphosed—less crystalline than many of the secondary rocks. Yet they must be amongst the very oldest sedimentary rocks known to us.

I may add that I found by actual experiment that in a deposit now forming here, of the same blue colour, Annelid burrows develop precisely the same ferruginous stains which I find in the Scalpa specimen before referred to. ARGYLL.

Inveraray, Argyllshire.

Mr. Galton on Natural Inheritance.

MR. GALTON's recent ingenious book on natural inheritance suggests some remarks on the value of his method and results. In the first place, it is plain that the method of probable error, which he uses, is only applicable with any certainty to cases where a multiplicity of unknown or unanalyzed causes ("accidents," pp. 19, 55) determines some mathematically measurable quality. Eye colour, artistic faculty, and temper, to which Mr. Galton applies his method, are not mathematically measurable qualities, and his results, self-consistent though they are, are scientifically untrustworthy because of variation in the standard of popular judgment in such matters. Stature, however, comes properly within the range of his method, and Mr. Galton has made the most of this point.

The method employed by Mr. Galton may be styled a mathematical interpretation of the law of uniformity of nature as apparent in the tendency of progression and regression to an average for all new examples of measurable qualities. (By the way, it is curious that Mr. Galton does not employ the term progression, instead of making regression cover all movements both upward and downward to an average. Rise to an average is certainly progress.) The comparatively easy method of average in dealing with such problems as heredity in the lump is hardly, what Mr. Galton claims it to be, the pioneer method in the "science of man" (p. 62). Indeed, the method of chance is infertile in both biology and sociology so far as it mistakes statements of average tendency as in any wise comparable in value to the particular predictions given by inductive inquiry. The continued use of such terms as accident and chance to cover a multitude of undetermined particular causes may be directly hurtful so far as this tends to slur over the patient investigation of special cases. The greatest so-called accidental variations, or "sports," have, of course, their reason in a peculiar conjuncture of influences, and the exact determination of these, specially with reference to stable stocks, would be of the greatest scientific and practical value. The method of chance can never be an aid to progress, for it always fails in particular predictions, and reduces our outlook to the level plain of averages.

In a book on natural inheritance we should expect some thorough treatment of the relation of heredity to other factors, and a clear exposition of how it can be isolated from them in its effect, especially upon stature. But the statistics employed are avowedly statistics of stature and not of heredity: how, then, are the results made to stand not merely for stature but also for heredity? Mr. Galton concludes that his results for stature are really laws of heredity because of the peculiar relations of the ratios obtained (p. 132), and also because the results are confirmed by general deductions from the laws of chance (p. 102). But as to this first point we must regard it as assumed rather than proved that kinship is to be measured by the comparison of ratios of deviations amongst kin. If we knew from other investigations or *a priori* that the influence of heredity on regression is in the numerical order given, then Mr. Galton's results would be merely confirmatory evidence. The laws of heredity must be based on the facts of heredity, or it must be clearly shown by the method of elimination that given results can only be ascribed to heredity. Does Mr. Galton accomplish this? He slurs over other influences than heredity (*e.g.* education, p. 156), or he hastily concludes them to be in harmony with heredity (*e.g.* natural selection, p. 119). He also does not satisfy us on the equal influences of parents in heredity (p. 98), which is a fundamental assumption for his process. That the average regression of the son to the general average of stature is by one-third parental deviation (p. 104) does not, on the face of it, prove anything with regard to transmission of stature. I cannot see that Mr. Galton has clearly shown this ratio to be more than a law of stature as determined by all influences and not by heredity alone. To make the ratios obtained a "measure of family likeness" (p. 132) is certainly unproved till it is shown that heredity alone enters into the data upon which the ratios are founded. It is plain that in any case, whether the cause be heredity alone or heredity plus many other influences, certain definite ratios will be obtained for father, son, brother, &c.

As to the way in which an abstract calculation of the laws of chance confirms Mr. Galton's statistics, it is enough to observe that no evidence is adduced why the results attained should not stand for the multiple "accidents" of environment, nourishment, occupation, heredity, &c., rather than to "accidents" of heredity alone. Mr. Galton fails to prove that his ratios are not the mathematical expression for the operation of the law of frequency of error as applied to the chance operation of heredity plus other agencies, rather than the formula for heredity simple and unadulterated.

But stature is undoubtedly modified by many prenatal conditions which do not come under the head of heredity, and it is certainly modified by climate, nourishment, and occupation. It is quite likely that human dwarfs might be raised upon the same principles as the Japanese dwarf trees. Mr. Galton makes no deduction from his statistics for other influences than heredity, and his results stand as the expression of the law of frequency of error applied to qualities which are the effect of many complex causes beside heredity. HIRAM M. STANLEY.

Lake Forest University, October 5.

Head Measures at Cambridge.

I AM pleased to be able to say, with reference to criticisms by your correspondents on the trustworthiness of the head measures at Cambridge, and on the deductions made by myself from the results obtained by Dr. Venn after he had discussed the first batch of them, that he is now about to discuss a second batch. The observations that have since accumulated are about equal in number to those already dealt with, and the new results will afford an efficient check upon the value of those already published. I hope also that Dr. Venn may find adequate material to determine the "probable error" of a single head measure, by means of the differences (discussed under obvious restrictions) between the recorded measures of the same persons at different times. We shall then be better able than we are now to estimate the degree of reliance to be placed on the mean value of any given number of head measures. FRANCIS GALTON.

Trimorphism in *Scabiosa succisa*.

THIS species is usually described as gynodiœcious. Hooker ("Student's Flora") thus refers to it. Darwin ("Forms of Flowers") says, "I have observed the existence of two forms in our endemic *S. succisa*"; further, "From what Lecoq says ('Géographie Botanique') *S. succisa* appears to occur under two forms in France"; and again, "According to Lecoq, the female flower-heads of *S. succisa* are smaller than those of what he calls the male plants, but which are probably hermaphrodites." Hermann Müller ("Fertilization of Flowers") also speaks of *S. succisa* as existing under two forms in Germany.

I have recently discovered that the species really exists, in this country at least, under three very distinct forms, viz. (1) the original hermaphrodite; (2) the small female form described by Lecoq; and (3) a second female form, larger even than the hermaphrodite, and differing from the first in a very remarkable manner. I will describe the three forms in detail.

No. 1 (hermaphrodite). Average measurements of 100 capitula: diameter at the base $\frac{13}{16}$ inch, height $\frac{17}{32}$ inch. Average number of florets per capitulum 86 (highest 111, lowest 53). Corolla lavender. Filaments incurved in bud, afterwards erect, and twice as long as the corolla-tube. Anthers pink. Style about $\frac{7}{16}$ inch long, thin, remarkably erect, purple, glabrous. Plane of stigma at right angles to the style. Development of style does not take place till anthers have fallen, when stigma becomes viscid.

No. 2 (straight-styled female). Average measurements of 50 capitula: diameter $\frac{5}{8}$ inch, height $\frac{3}{8}$ inch. Average number of florets 61 (highest 79, lowest 52). Florets very small. Corolla with a deep lilac tinge. Stamens abortive, filaments very short, within the tube. Rudimentary anthers yellow. Style about $\frac{3}{8}$ inch long, otherwise precisely as in No. 1, but development begins as soon as the floret opens.

No. 3 (bent-style female). Average measurements of 150 capitula: diameter $\frac{7}{8}$ inch, height $\frac{9}{16}$ inch. Average number of florets 58 (highest 79, lowest 22). Florets very large, and more loosely packed on the receptacle. Corolla blue, with a lavender tinge. Stamens as in No. 2. Style about $\frac{9}{16}$ inch long, very stout, much swollen at the base (? honey-gland), usually white, stigma green. Plane of the stigma much inclined. Styles much bent and twisted. The whole surface of the corolla clothed with long stellate hairs. These are thickest on the face of the limb, which in the other forms is quite glabrous. The style is also thickly covered with similar hairs, which are much crowded immediately below the stigma. To these hairs an immense number of pollen grains may be found adhering. The hairs are not fully developed until the stigma is mature.

Forms in some respects intermediate between Nos. 1 and 2, and between Nos. 1 and 3, are occasionally found, and this might be expected, as Nos. 2 and 3 are obviously descended from the hermaphrodite No. 1. I have never, however, found a single individual in any sense intermediate between Nos. 2 and 3, which appear to be two distinct female forms developed from No. 1 along different lines.

These two forms, it will be observed, differ remarkably from each other in the following points, viz. size of capitulum, size of florets and arrangement on the receptacle, colour of corolla, stoutness, colour and general form of style, and in the absence or presence of stellate hairs.

The stellate hairs are utilized to catch stray pollen-grains detached from the bodies of insect-visitors coming from neighbouring hermaphrodites, most of which would otherwise be wasted. As it is, they are retained by the hairs until the arrival of other insects, which in depressing the already bent and twisted styles bring their viscid stigmas into contact with the pollen-grains collected by the hairs of adjacent florets—a result facilitated by the manner in which the stigma is set on the style. By this arrangement the chances of fertilization are much increased, as each stigma generally receives a full share of pollen.

With regard to the relative size of the three forms it is remarkable that while one of the female forms is so much smaller than the hermaphrodite (as is the case, according to Darwin, in all gynodiœcious species known to him), the other even exceeds it in size. It is also noteworthy that the capitulum of the second female form, although larger than that of the hermaphrodite, contains a much smaller number of florets, and these are very large.

I can discover no rule as to the distribution of the different forms. In one station near here (a large common) all the plants are hermaphrodites. In a certain wood where the species abounds, the "bent-styled" females appear to be nearly as common as the hermaphrodites, while no "straight-styled" females can be found. In another wood, not half a mile distant from the first, the "bent-styled" form is almost entirely supplanted by the "straight-styled," which is plentiful. Lastly, in a fourth station (a barren strip of ground by the roadside), all three forms are found growing together. ARTHUR TURNER.

Box Hill, September.

On the Aquatic Habits of Certain Land Tortoises.

IT has always proved of more or less interest to me to observe the method of aquatic locomotion adopted on the part of any of our strictly terrestrial vertebrates, and never is this more keen than when the opportunity has been afforded to study the swimming propensities of certain of our Reptilia. Most snakes swim well, but who of us has not been surprised upon first observing the violent wriggling, froward-propelling motions of some of the smaller lizards when they are thrown out into the water some little distance from the shore? The American chameleon (*Anolis principalis*) well illustrates this last; and this lizard, in common with others, seems to possess an actual dread of getting into deep water. For a long time it has been known that most species of the so-considered stricter types of land tortoises soon drown when placed in water of any considerable depth, and it would be but natural to suppose that such species would avoid that element as far as possible, but I have found this by no means always to be the case. Take the ordinary land turtle of the United States (*Cistudo carolina*) for example: it will voluntarily enter the water under certain circumstances. Not long ago the writer noticed one of these hunting for food in three or four inches of water along the edge of a pond that had rising banks; and the first time I discovered the nest of this variety the eggs were deposited in the water in a depression at the miry margin of a marsh. But this is not all, for if we place one of these reptiles upon a little island of land, well removed from the shore, and surrounded by water several feet in depth, and withdraw to watch its movements, we note that as soon as it satisfies itself as to its position, it will, without further ado, take at once to the water and swim to the nearest shore. It does not, however, sink beneath the surface, but, holding its head high out of that element, and filling its lungs with air, strikes out vigorously, with alternate pairs of feet, until it accomplishes its purpose, and regains the mainland. How far one could swim in this manner I am unable to state, but that it would not exceed a few yards I am quite certain. Nevertheless, even the power to accomplish the feat to the extent indicated might, under a variety of circumstances, have its influence upon the distribution of the species, or of any species of typical land tortoise, and it would be interesting to know how far this power may be enjoyed by this class of reptiles generally.

Smithsonian Institution, R. W. SHUFELDT.
Washington, D.C., September 13.

Delambre's Analogies.

FOUR of the most important formulæ in spherical trigonometry were given by Gauss, without proof, in his "Theoria Motus Corporum Cœlestium" (1809), and were therefore called Gauss's theorems or analogies.

They were, however, given by Mollweide in Zach's *Monatliche Correspondenz* for November 1808, and before that by Delambre in the *Connaissance des Temps*, issued in April 1807, so that they are now justly ascribed to the latter.

They may be deduced in the most simple manner from Napier's analogies, and thus easily remembered.

Napier's analogies are—

$$\tan \tfrac{1}{2}(A + B) = \frac{\cos \frac{1}{2}(a - b)}{\cos \frac{1}{2}(a + b)} \cdot \cot \tfrac{1}{2}C \qquad (\alpha)$$

$$\tan \tfrac{1}{2}(A - B) = \frac{\sin \frac{1}{2}(a - b)}{\sin \frac{1}{2}(a + b)} \cdot \cot \tfrac{1}{2}C \qquad (\beta)$$

$$\tan \tfrac{1}{2}(a + b) = \frac{\cos \frac{1}{2}(A - B)}{\cos \frac{1}{2}(A + B)} \cdot \tan \tfrac{1}{2}c \qquad (\gamma)$$

$$\tan \tfrac{1}{2}(a - b) = \frac{\sin \frac{1}{2}(A - B)}{\sin \frac{1}{2}(A + B)} \cdot \tan \tfrac{1}{2}c \qquad (\delta)$$

$$\text{Let } m \cdot \sin \tfrac{1}{2}(A + B) = \cos \tfrac{1}{2}(a - b) \cos \tfrac{1}{2}C \,. \qquad (1)$$

$$\therefore\ m \cdot \cos \tfrac{1}{2}(A + B) = \cos \tfrac{1}{2}(a + b) \sin \tfrac{1}{2}C \,. \qquad (2)$$

These are numerator and denominator of (α).

$$\text{Let } n \cdot \sin \tfrac{1}{2}(A - B) = \sin \tfrac{1}{2}(a - b) \cos \tfrac{1}{2}C \,. \qquad (3)$$

$$\therefore\ n \cdot \cos \tfrac{1}{2}(A - B) = \sin \tfrac{1}{2}(a + b) \sin \tfrac{1}{2}C \,. \qquad (4)$$

Numerator and denominator of (β).

Square, and add—

$$\therefore\ m^2 + n^2 = 1.$$

Divide (4) by (2), and it follows by (γ) that—

$$\frac{n}{m} = \tan \tfrac{1}{2}c\,;$$

$$\therefore\ m = \cos \tfrac{1}{2}c,\ n = \sin \tfrac{1}{2}c.$$

Substitute these values, and (1), (2), (3), (4), are Delambre's analogies. R. CHARTRES.

Classified Cataloguing.

THE principle suggested by Mr. Petrie, on "Classified Cataloguing" (NATURE, August 22, p. 392), is already successfully used in many of the chief libraries of the United States, having been originated by Mr. Melville Dewey, while Librarian at Amherst College. It is equally applicable to collections of all kinds, and the classification has already been extended to a considerable extent in certain departments, particularly in botany, and is capable of unlimited extension. It possesses all the advantages mentioned by Mr. Petrie, but is broader, inasmuch as it includes all subjects.

In the "Decimal Classification" of Mr. Dewey (Boston, 1885, second edition), we find, for illustration, under 500, General Science; 580, Botany; 583, Dicotyledonæ; 583·9, Apetalæ; 583·95, Unisexuales, 583·951, Euphorbiaceæ; 590, Zoology; 598, Reptiles; 598·13, Chelonia, &c.

If an extension of this system, which would, I have the means of knowing, be most acceptable to Mr. Dewey, were to be adopted for general museum use, the advantages would be incalculable. JAS. LEWIS HOWE.

Polytechnic Society, Louisville, Kentucky.

Valuable Specimens of Vertebrates for Biological Laboratories.

WHAT specimens of Vertebrates are the best to be used by the student in the biological laboratory? This is certainly a very important question. In Europe, the following animals are generally dissected: some fish, the common frog, the pigeon, the rabbit, or the guinea-pig. The frog is a very aberrant member of the Batrachia, and it would be very instructive for the student to examine a more typical representative of the class. Such a one is the American Proteus (*Necturus maculatus*, Ref.), used at Cornell University, Ithaca, N.Y. During the last few years I have received many specimens of Vertebrates from two fishermen—Mr. Russell Dee and Mr. F. C. Audibert, from Marietta, Ohio. Lately, Mr. Audibert has written to me that he could procure any quantity of material, if wanted, and he would charge only 25 cents. (a little over one shilling) for each specimen. From the list of specimens sent to me by Mr. Audibert I select the following, which appear the most important for laboratory use:—

Accipenser maculosus, Les.
Polyodon folium, Lat.
Lepidosteus osseus, L.
Necturus maculosus, Ref.
Menopoma alleghaniensis, Daud.
Trionyx muticus, Les.

The instructive value of these specimens is certainly very great, and the low price could enable any biological laboratory to secure this material. G. BAUR.

New Haven, Conn., September 30.

"Darwinism."

IT has now become to me a matter of amusement to note how those naturalists who of late years have drifted most widely from the doctrines of evolution as these were held by Darwin, habitually accuse me of Darwinian heresy because I have not seen any adequate reason to depart from those doctrines in their entirety. Perceiving that there has been some change of relative position, while failing to perceive that the movement has been altogether on their own side, these naturalists represent that I have been falling away from Darwinism, when the fact is that they have been advancing beyond anything that was ever countenanced by the judgment of Darwin—and even expressly accepting the view which he so vehemently rejected, viz. that of regarding natural selection as the sole cause of organic evolution. Thus, for example, when in NATURE of October 10 (p. 569) Prof. Ray Lankester gravely designates my paper on physiological selection a "laborious attack upon Darwin's theory of the origin of species," it becomes evident how fast and far he has travelled from his Darwinism of two or three years ago. For, to put it briefly, unless it can be shown that Darwin considered natural selection the only possible cause of organic evolution, and did not consider sterility between allied species as probably due to some other principle of change, it is obvious that there *can* be nothing in my "additional suggestion on the origin of species" which may in any sense be designated an attack upon the distinctively Darwinian theory. Yet it is with regard to these very points that the opinion of Darwin was steadily opposed to that of Wallace; *i.e.* to the present opinion of Lankester. Therefore, quite apart from any question touching the truth of this "additional suggestion" or "supplementary hypothesis" (which, however, I may here parenthetically remark, will soon be shown to be in no way seriously affected by Mr. Wallace's sole remaining criticism), it is sufficiently evident that, when the object of publishing the hypothesis was expressly and repeatedly stated to have been that of meeting the main difficulties which had been advanced against the theory of natural selection, the present designation of this hypothesis as an elaborate attack upon that theory is simply absurd.

But my object in now writing is to state, *apropos* of Prof. Lankester's remarks on the inadequacy of Mr. Wallace's criticism of Mr. Gulick's paper, that I have just received a communication from the latter gentleman (who writes from Japan), requesting me to exercise my discretion as to publishing in these columns a reply to that criticism. Unfortunately this reply is too long for insertion, and as I do not see how it can be curtailed without serious detriment, I have refused to incur the responsibility of publishing it in an abbreviated form. At the same time it seems but just to let the readers of NATURE know that a full reply to Mr. Wallace's criticisms (in these columns and elsewhere) has been prepared; since otherwise the silence of its author might be misinterpreted.

To me it appears that Mr. Gulick's work is much the most profound that has ever been published on the important matters of which it treats (viz. isolation in all its forms, with its consequences in "segregate breeding" and "divergent evolution"); and therefore I am glad to take this opportunity of recognizing his priority, by some fifteen years, in thinking out, and largely verifying by his researches on land shells, the theory of physiological selection. GEORGE J. ROMANES.

Geanies, Ross-shire, October 12.

Sunset Glows.

IT is a curious fact that a revival of sunset-glows, similar to those described by Sereno E. Bishop in a letter published in NATURE for August 29 (p. 415), was observed in Western New York at almost precisely the same time that he saw them at Honolulu. I inclose a clipping from the *Rochester* (N.Y.), *Democrat and Chronicle*, which was published on July 21:—

"The skies at evening show signs of the gradual return of the red light. It will be of interest to ascertain if the phenomenon reappears as the solar disturbances continue to increase in energy to the maximum. It is quite apparent now that the minimum has been passed, and the tendency is toward an increase in the number and in the violence of solar disturbances. There are certainly three and probably four well-defined disturbances at present." M. A. VEEDER.

Lyons, New York, September 13.

"The Teaching of Science."

I BEG that the following alterations may be made in the "Suggestions for a Course of Elementary Instruction in Physical Science," printed in NATURE of October 17. HENRY E. ARMSTRONG.

P. 602, Problem II., line 11 from above, read "by means of iron" instead of "by means of phosphorus."

P. 603, Problem VII., line 20 from below, instead of "when metals are heated with acids," read "when metals are dissolved in acids."

P. 604, Problem IX., line 31 from above in right-hand column, read "dried hydrogen," instead of "dried oxygen."

P. 605, Problem XII., line 17 from above in right-hand column, read "zinc oxide," instead of "lime oxide."

TELESCOPES FOR STELLAR PHOTOGRAPHY.[1]

II.

IN considering the essentials of a good system of control for equatorial clocks, it is necessary to keep in view the exact conditions required. It is not sufficient that the controlling apparatus (of whatever form it may be) should simply bring the *rate* of the clock, which has been interfered with by some adventitious disturbance, correct once more; it must do more, it must correct this error. For, suppose a star be set on the slit of a spectroscope, and the clock started, and say, as in Dr. Huggins's case, a photographic plate inserted for a two hours' exposure. Now suppose that five minutes after the commencement of the exposure, an error of one-tenth or two-tenths of a second occurs from some disturbing cause (a fragment of dirt on the tooth of a wheel, or other cause); if the controlling apparatus be of such a nature as simply to bring the clock-rate correct again, the position of the telescope will be the above quantity, one-tenth or two-tenths of a second, in error for the remainder of the exposure, although the rate may be absolutely correct for the whole times. In other words, the star will have moved off the slit, by a quantity equivalent to what the instrument would move in one-tenth or two-tenths of a second, and will continue off the slit for the remainder of the two hours. So it will be seen that no controlling apparatus is of any use whatever, unless, as well as keeping the rate uniform, it corrects the errors that have crept in. In consequence of not keeping this point in view, many most ingenious but useless arrangements have been from time to time proposed. A little consideration will show that this arrangement meets all requirements.

The above arrangement is somewhat similar to Dr. Gill's.

[1] A Paper read by Sir Howard Grubb, F.R.S., before the Society of Arts, on April 18, 1888. Continued from p. 444.

It is simpler to attach to any existing clock, but not so delicate as his, and is open to the same objections. It is, however, capable of very good work, as may be judged from the chronograph sheet of the Dunsink Observatory chronograph.

The third is the form of control which I devised for Mr. Isaac Roberts, and which has been so successful with him, and with Prof. Pritchard (who has had it recently attached to the Oxford equatorial), that photographs have been exposed with the telescope to which it has been attached for fifteen minutes, and yielded perfect images of stars without any hand and eye guiding.

The arrangement consists, firstly, of a *remontoire* train, driving a good mercurial or other compensated pendulum—the driving of this train being of course entirely independent of the equatorial clock giving motion to the telescope; secondly, of a detector apparatus, which detects any difference between the rate of this standard pendulum and the equatorial clock; and thirdly, of a correcting apparatus, which corrects automatically any error discovered by the detector. This corrector itself consists of two parts—an "accelerator" and a "retarder"—and these we will first proceed to describe.

In S S′ S″ is one of the shafts, between the driving train of the equatorial clock and the worm which drives the right ascension sector, this shaft being cut into three parts, denoted by the letters just named. At one end the portion S of the shaft carries a wheel, 1, immediately adjoining which is the wheel 2, mounted on the portion S′ of the shaft. At the other end of this last-named section of the shaft is fixed a third wheel, 3, which is almost in contact with the wheel 4, fixed on the end of the shaft S″. The shafts S and S′ also have mounted freely on them the brass disks, *d d′*, which adjoin the two pair of wheels referred to above. Each of these brass disks is furnished with a stud on which a small pinion is mounted, the pinion *p*, belonging to the disk *d*, gearing across the pair of wheels, 1–2; while the pinion *p*, belonging to the disk *d′*, gears across the pair of wheels, 3–4.

Under normal conditions, if no error exists in the equatorial clock rate, the arrangement of wheels and pinions just described revolves as one piece, the three sections, S S′ S″, of the shaft rotating at the same speed; but it is possible by an arrangement which we shall explain presently, to stop the rotation of either of the disks, *d d′*, and as soon as this occurs the pinion of the stopped disk has to act as a transmitter of motion from one of the wheels into which it gears to the other. If the two wheels of each pair had the same number of teeth, the speed of both wheels would still remain the same, but in reality the number of teeth in the two wheels of each pair is different, and hence the stopping of one of the disks, *d* or *d′*, causes a variation in the rate of rotation of the two adjoining wheels relatively to each other. For instance, in the case of the first pair of wheels, let wheel 1 have 30 and wheel 2 have 29 teeth, and suppose that the shaft S is rotating once every 60 seconds. Thus, if the disk *d* be stopped, the wheel 2 will be made to revolve in $\frac{29}{30}$ of the time occupied by the wheel 1, or in other words the rate of the section S′ of the shaft will be accelerated to one revolution in 58 seconds. In the same way by reversing the positions of the wheels in the other pair 3–4, the stoppage of the disk *d′* can be made to effect a retardation of the portion S″ of the shaft relatively to S′. The edges of the disks *d* and *d′* are cut into very fine teeth, and the stoppage of the disks when desired is effected by causing a comb attached to the armature of an electro-magnet to engage with these teeth.

The whole apparatus just described constitutes a very convenient arrangement for accelerating or retarding the driving motion imparted to the telescope by the equatorial clock, and that it is capable of very good work is shown by the photographs which have been taken by Prof. Pritchard and Mr. Roberts, in which the star disks are perfectly round, though exposed for 15 to 60 minutes, and no hand guiding used.

I have now to describe how this apparatus is, when necessary, automatically brought into action by the "detector."

In Figs. 5, 6, and 7,[1] W is a scape-wheel mounted on the sixty-second spindle of the controlling clock, and driven from that spindle through a spiral spring, X X, so that no error in the equatorial clock can affect its rate or that of the standard pendulum. On the same spindle there is also mounted behind the scape-wheel an ebonite disk, E E, Fig. 5; this disk, which is driven by the equatorial clock, carrying two insulated rings, *b b′*, which are respectively connected metallically with two platinum plates, B B′, inserted in the face of the disk. Between the scape-wheel and the ebonite disk there is also mounted loose on the spindle a lever, A A, which carries at one of its ends a platinum bridge, B, which is of such a length as to fit between the platinum plates, B B, and which in its mid-position bears against a piece of rock crystal let into the ebonite disk between the two plates just named. At the other end the lever, A A, is formed into a fork, between the arms of which projects a pin carried by the scape-wheel; the arms of the fork are provided with set screws,

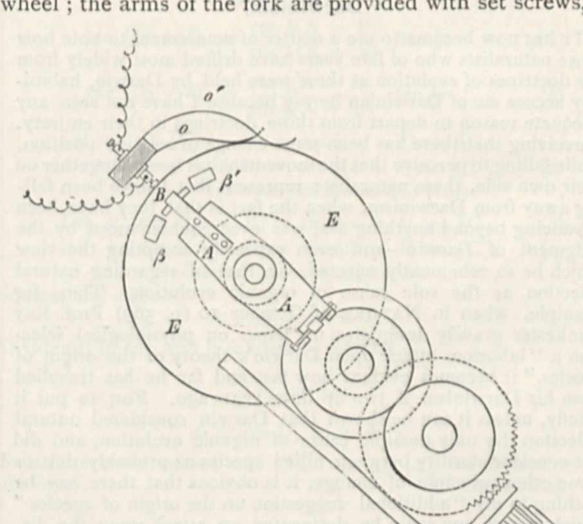


Fig. 5.

by means of which the amount of play allowed to this pin in the fork can be adjusted.

The insulating rings, *b b′*, are electrically connected with the accelerator and retarder already described by means of fine platinum wires, O O′, wiping against them, and the action of the whole arrangement is as follows. The scape-wheel, W, being driven by the control clock, has an intermittent movement corresponding to the beats of the pendulum, while the ebonite disk, E E, being driven by the equatorial clock, has a constant movement, so that even if the scape-wheel and disk make a whole revolution in the same time, the pin carried by the scape-wheel will be constantly oscillating between the pins of the fork at one end of the lever, A, this lever being driven by friction from the ebonite disk. The pins just named are adjusted so as to allow of this oscillation taking place without interference, so long as the rates of the equatorial and control clocks remain uniform, but if the equatorial clock either loses or gains with respect to the standard, the pin on the scape-wheel comes into contact with one of the fork pins of the lever, A, and shifts that lever on the spindle, bringing the bridge, B, into contact with one of the platinum plates,

[1] These blocks have been kindly lent by the editor of *Engineering*.

B or B', and transmitting a current which brings into action the accelerator or retarder as may be required. The period during which the accelerator or retarder remains in action will depend upon the amount of the error to be corrected, and the proportions of the pairs of wheels, 1, 2, and 3, 4. With the proportions described above, the correction introduced is one-thirtieth of the rate, so that, to correct an error of one-fifth of a second, the accelerator or retarder, as the case may be, would have to remain in operation $\frac{30}{5} = 6$ seconds. As soon as the correction has been made, the lever, A, will resume its normal position, and the bridge, B, coming then between the two platinum plates, B B', a current will cease to be transmitted, and the accelerator or retarder thrown out of action.

It is to be noted that the apparatus above described not only corrects any temporary disturbance of the equatorial clock rate, but cancels errors which have already occurred.

It will be seen that the third form of control is free from the objections of the first and second. The detector part of the apparatus is close to the screw spindle, only removed from it by one pair of wheels, and the correction is not applied in the same manner by checking the speed of the clock, but by introducing a differential gear, which acts until the error be cured, and then drops out of gear automatically.

The fourth and last form of control, however, is that to which I would invite your special attention, for I believe it to be capable of results beyond all the others.

I have endeavoured in it to select all the good points of the other forms, and to combat the weak points. I may not have as yet produced it in as perfect a form as is possible, but I am satisfied it is capable of development into a very perfect control, and even at present it is the most perfect I have constructed.

As long as the control applied its correction by altering the speed of the governor, it was necessary to keep down the *vis inertia* of the governors, but now, as the correction is not applied in this way, I have made the governor very heavy, and running at a very high speed.

The *vis inertia* of the governor is represented by some 10,000 foot-pounds per minute; consequently it is little affected by any small or short differences in friction or driving powers.

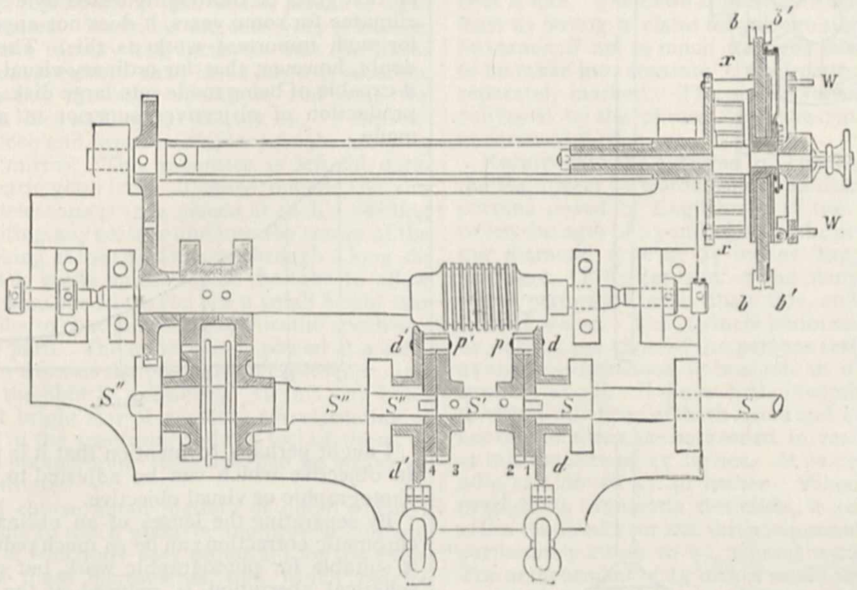


Fig. 6.

Again, at the suggestion of Dr. Gill, I make the governor spindle gear directly into the counter spindle of the screw, in order to have as few wheels and pinions to deal with as possible. Errors of wheels behind the governors have nothing whatever to do with the accuracy of its rate.

As to the nature of the control, I use Dr. Gill's form of detector and my own form of corrector, viz. accelerator and retarder. I use Dr. Gill's detector because it seems to be capable of being made on a larger scale than mine, and consequently ought to be more delicate.

I now propose to say a very few words on the optical part of the instrument.

The first question that naturally occurs is whether a refractor or reflector should be used. I own that when I first considered the subject I inclined to the belief that reflectors would be found to be the most suitable; and in a paper of mine, which was read before the Royal Astronomical Society last spring, I urged that comparative trials should be made before a final decision was arrived at. I have found reason, however, to modify my views on this point.

My reason for thinking that the reflector might possibly prove the best was founded on the consideration that in reflecting instruments rays of all refrangibilities are brought to a focus at one and the same point, whereas in the refractor rays of various refrangibility have different foci, and the best we can do is to so arrange the curves that those rays most active in impressing the photographic plate may be brought as nearly as possible to the one focus.

If we draw a curve which represents the position of the focal point for various rays of the spectrum in an object-glass corrected for photo work, it will be something like this figure (Fig. 8). The same for a reflector will be represented by a straight line. Looking at these curves it is certainly a natural conclusion that the reflector ought to be best, and therefore it was that I urged that a fair comparative trial should be made between the reflector and refractor as to their suitability for this work.

The Congress, however, decided upon the use of refractors, from the simple fact (as Dr. Gill says) that the best work done (to that time) had been done by refractors, not taking into consideration the very much more favourable conditions under which the refractor photographs were taken. Since that time further experiments have been made with both forms of instruments, which tend to show that, as against the refractor of the ordinary construction, the reflector can well hold its own, but that while it is obviously impossible for the optician to improve the field of the reflector, it is by no means impossible to do so with the refractor, and time and patient experimenting have shown that, by a modification of the curves of an objective, equally good definition of the central pencil can be obtained, combined with a very much better and flatter field, so that, however well reflectors could compete with the ordinary form of refractor, they cannot do so with forms constructed with special reference to field.

It should be borne in mind that the question of field is one which the optician was never before asked to consider

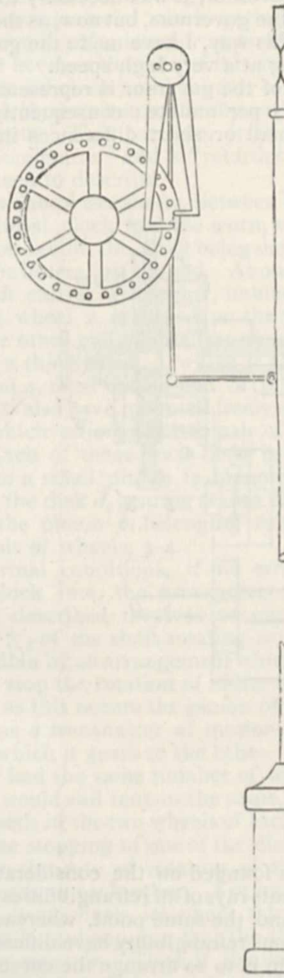


Fig. 7.

in telescope objectives. The field of such a sized telescope used for visual work would not be more than ½°, even with the lowest power. It has been found possible to obtain good definition over a field of 2° with either reflector or the ordinary form of refractor, and with the modified form considerably more. This question of field is, as I said, a very important one, for on it depends the amount of time required to complete the survey. If one instrument gives equally good definitions over 3° square, *i.e.* nine square degrees, as another does over 2° square, *i.e.* four square degrees, it is evident that the first instrument, equally energetically worked, is capable of completing the survey in less than half the number of years it is possible to do with the second instrument.

There is one point connected with this question of field which is of great importance.

Various forms of objectives give various characters of images of star disks at the edge of the field. Some give a bright nucleus with a tail like a comet, some assume a form approaching to a cross, and some give elliptical disks.

Of course perfection would mean absolutely circular disks all over the plate, but when this cannot be obtained, the last or elliptical disks are very much preferable to either of the others. It is quite possible to fairly estimate the most central point in an ellipse if the illumination over it be tolerably equal, but in the case of the comet or irregular form this is not possible.

The newer forms of objectives are peculiar in that the distortion of the lateral star images are of their least objectionable character.

It has been suggested that good results might be obtained by using the new "Jena" glass with rational spectra, but I have made inquiries respecting this, and it is not considered by the makers themselves that this glass in its present state would be suitable for the purpose of these photographic objectives. Until the permanency of that glass be thoroughly tested by exposure to various climates for some years, it does not appear safe to use it for such important work as this. There can be little doubt, however, that for ordinary visual work this glass, if capable of being made into large disks, will allow of the production of objectives superior to anything hitherto made.

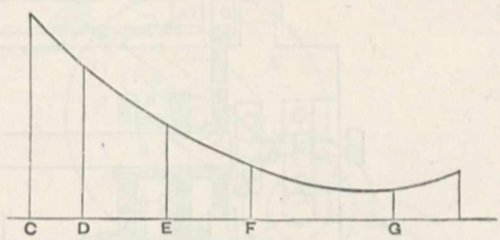


Fig. 8.

I ought perhaps to mention that it is possible to make an objective which can be adjusted to work either as a photographic or visual objective.

By separating the lenses of an ordinary objective, the chromatic correction can be so much reduced as to render it suitable for photographic work, but unfortunately the spherical aberration is reduced at the same time and definition destroyed.

Prof. Stokes, however, suggested to me that by constructing an objective in such a manner that the crown lens would be unequally convex by a certain amount, and that the spherical aberration would be correct when the flatter side was outermost, that then the chromatic aberration could be reduced as before by separating the lenses, and the reduced correction for spherical aberration raised by turning the crown lens with its more convex side outerwards.

This I tried, and found act perfectly.

I described this last spring at the Royal Astronomical Society, but it has since been re-invented in America.

It remains for me now only to describe how these new photographic objectives are tested.

The testing of objectives for visual work is a matter almost altogether of eye experience.

In these photographic objectives a different course must be adopted, as the image appears to be badly corrected to the eye when it is rightly corrected for photographic rays.

The Paris Congress decided that the rays G of the spectrum should have in their objectives a minimum focus; how is the correction to be verified? It is usual in the testing of the chromatic aberration of objectives, by those whose eye experiences cannot be a sufficiently accurate guide, to allow the image of a star, as found by the objective, to fall on the slit of a spectroscope, and to judge of the focus of each particular ray by the breadth of the spectrum at that ray. Wherever the light is brought to a focus the spectrum is of insensible breadth. When it is out of focus, a more or less sensible breadth, by moving the spectroscope in and out of the position of maximum and minimum foci, can be obtained.

I tried this plan, but found it very unsatisfactory, as it was very difficult to determine the exact place where the spectrum was narrowest, the curves being so very shallow.

After much thought I arrived at the following very simple and efficient plan, which I described in full, as it may be useful to some for other purposes. It should be remembered that the object is to get the focus of the objective for various parts of the spectrum.

If, therefore, we could obtain various objects when light was derived for such portions, and such portions only, of the spectrum as we required, our object would be accomplished.

I take a spectroscope with a fairly large dispersion equal to about 2 prisms of 60° and with a pencil of light of about 2° diameter. I remove the observing telescope, and substitute one of very long focus, so that the linear dimensions of the spectrum shall be as large as possible. I observe with this the solar spectrum, and note the position of such lines as I intend to work on. I then remove the eye-piece and insert in its place a tube carrying a small convex mirror. The apparatus is left till dark, and a small electric glass lamp attached outside the slit. The observing telescope is then placed at such a reading as I know will bring any certain line into the centre of the field, and on looking at the small mirror through a long slit which is purposely made on the top of the tube to allow it to be viewed from the front, you see a small bright star whose light is due to that particular line in the spectrum, and to no other part. The apparatus is placed at a sufficient distance in front of the photographic telescope, and these stars are the objects examined. In this way I can produce a small bright star of a colour corresponding to any of the lines in the spectrum, and the foci of these, as observed in the photographic telescope, can be measured with great exactitude.

There are, of course, small matters of detail which I have been unable to touch upon in the present communication, many of which are very important for the effective working of these instruments, and which require special treatment. I have, however, confined myself to the principal and more important parts, but I trust that I have been able to show that we have at least made a substantial advance; and it remains for us to hope that when these instruments are placed in the hands of astronomers they may yield a rich harvest of work, and leave their mark on the history of astronomical science.

HOWARD GRUBB.

ON THE PRINCIPLE AND METHODS OF ASSIGNING MARKS FOR BODILY EFFICIENCY.[1]

THE question to be solved is of this kind. Suppose that one man can just distinguish a minute test object at the distance of 25 inches, another at that of 35, and again another at 45 inches, how should we mark them? We should be very rash if we marked them in the proportion of 25, 35, and 45, or even if, for some good reason, we had selected 25 as the lowest limit from which marks should begin to count, we should mark them as 0, 10, and 20.

[1] Read at the British Association, by Francis Galton, F.R.S.; but slightly revised, in order to introduce the diagrams herewith printed. Followed by remarks on experiments made at Eton College, by A. A. Somerville.

Two separate considerations are concerned in the just determination of a scale of marks—namely, absolute performance and relative rank, which are apt to be confused in unknown and varying proportions.

Absolute performance is such as is expressed by the 25, 35, and 45 inches just spoken of. It is perfectly correct in some cases to mark, or let us say to pay, for this, and this alone, upon the principle of piece-work—namely, that the pay ought to be proportionate to the work accomplished, or to the expected output in after life.

Relative rank is, however, on the whole, a more important consideration than the absolute amount of performance by which that rank is obtained. It has an importance of its own, because the conditions of life are those of continual competition, in which the man who is relatively strong will always achieve success, while the relatively weak will fail. The absolute difference between their powers matters little. The strongest even by a trifle will win the prize as completely as if he had been strongest by a large excess. Undertakings where many have failed, are accomplished at last by one who usually is very little superior to his predecessors, but it is to just that small increment of absolute superiority that his success is due. Therefore it is clear that relative rank has at least as strong a claim for recognition as absolute performance, if not a much stronger one. They have each to be taken into separate consideration, and each to be separately marked. The precise meaning intended to be conveyed by the phrase "relative rank" will be better understood further on.

Recurring to the example of keenness of eyesight, let the test object be words printed in diamond type, and the persons tested be Englishmen of the middle classes, between the ages of 23 and 26, then the performance of readtng diamond type at 25 inches happens to be strictly mediocre. Fifty per cent. of the many persons who were tested performed better than this, and 50 per cent. performed worse. The 35-inch performance was exceeded by only 2½ per cent. of the persons tested; and as to the 45-inch performance, it has not in my experience been reached at all. I have had altogether 12,000 persons tested in this way, of both sexes and of various ages, but not one of them has succeeded in reading diamond type at the distance of 45 inches. It is very rare to find one who can do so at 40 inches. Wherever superiority in eyesight is eminently desirable, it would be absurd to make the marks for the three supposed cases to run proportionately either to 25, 35, and 45, or to 0, 10, and 20. The achievement of 45 inches would deserve much higher recognition. Relative rank and absolute performance should not be confused together.

I use the term relative rank in a large sense, with reference to all persons who have been, or are likely to become, candidates, and not to the small number of them who may happen to be present at a particular examination. Statistical tables concerning the class of persons in question have to be compiled from past examinations, and the rank of the individual has to be determined amidst these. I have often described how this is to be done ("Natural Inheritance," p. 38, Macmillan and Co., 1889), but the diagram (Fig. 1) is, I think, the simplest of all forms for the use of an examiner. It tells at a glance the rank held by a man among his fellows in respect to any single and separate faculty. The class from which it is constructed might consist of any large number of persons subject only to the condition that the distance between the limits *within which* it extends shall be always divided into centesimal grades; that is to say, running from 0° to 100°. The grades are printed along both the top and the bottom of the diagram, and refer alike to every line. As a specimen of the way to read it, let us take the line of keenness of eyesight among the males. Here we see that the performance of reading diamond type at the distance of 25 inches is appropriate to grade 50°; or, as already stated, 50 per cent. of all the persons tried did worse, and 50 per cent. did better. Therefore the performance in question is exactly mediocre. Again, 30 inches corresponds to grade 80°; in other words, 80 per cent. did worse and the remaining 20 per cent. did better. The method on which this diagram is constructed is of universal application. Calling the particular class of persons to which it refers, for brevity, by the letters I.H.E. (International Health Exhibition), then the rank of any individual among the I.H.E. males, aged 23-26, in respect to any of the qualities therein named, can be most easily ascertained; also among the I.H.E. females of the same ages.

This method admits of being extended in more than

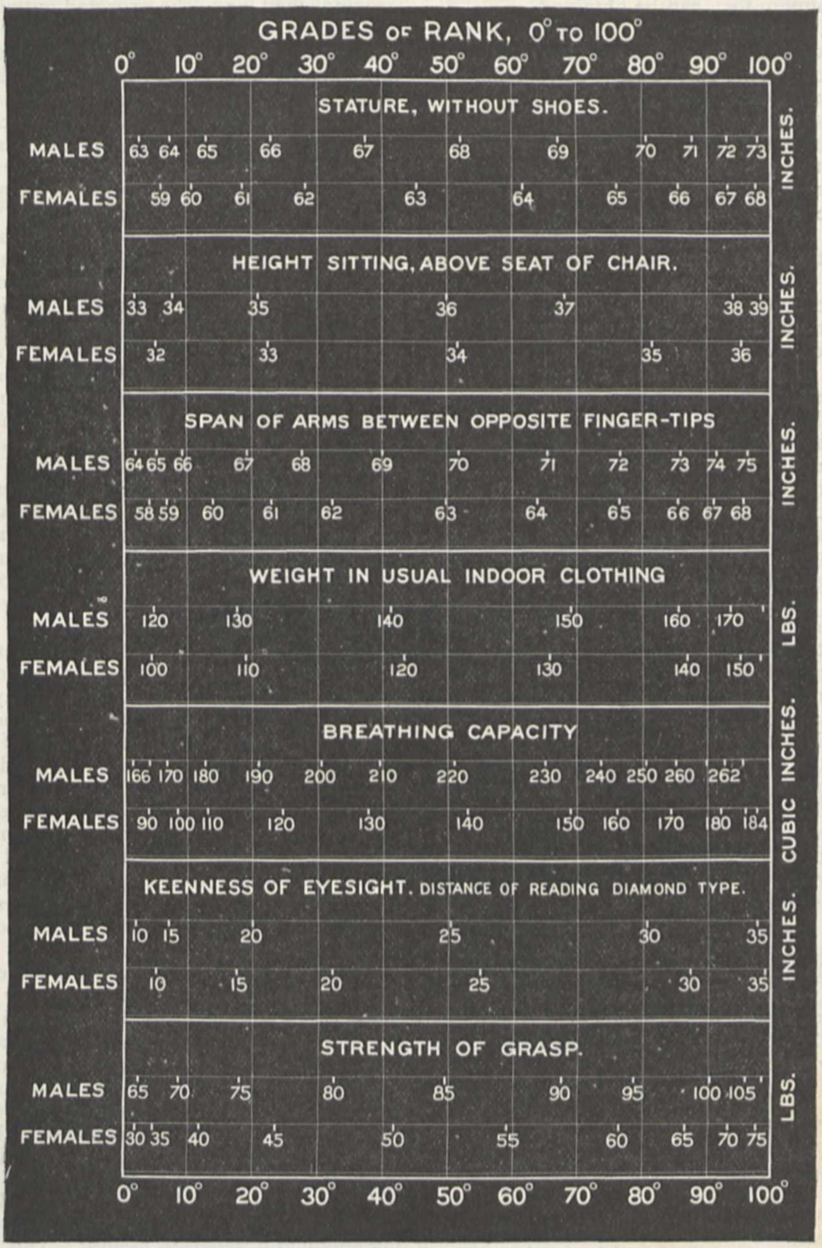


FIG. 1.

one way. That for which there is most call is where the rank of the quality immediately in question, has to be considered in reference to some other quality. Thus it is of little use to know the breathing capacity of the man unless we also know his stature or his weight. Lungs capacious enough to enable a small man to labour violently without panting would be wholly insufficient for the ordinary purposes of a giant, just as an excellent little boiler for a small steam-engine would be ineffective with a large one. The diagram (see Fig. 2) appropriate to the case we are considering, could not be compressed into a single line, but requires many. Successive lines in that figure refer to the successive statures of 60 inches, 61 inches, and so on up to 72 inches. A diagram of breathing capacities for each of these statures was constructed in pencil, on the principle of one of the lines in Fig. 1; then bold lines were drawn from above downward to connect all the pencilled entries of the same value, just as isobars, isotherms, and other contour lines are drawn (to which the general name of *isograms* might well be given). This completed the figure, which hardly needs further description, either how to make or to use it. The importance of taking stature into account now becomes very evident. A breathing capacity of 220 cubic inches in a man of 72 inches stature has the rank of only 6°, but in a man of 60 inches it has the rank of 94°. Fig. 3 shows in a similar way the grade of any given strength of grasp, when the weight of the person is taken into account.

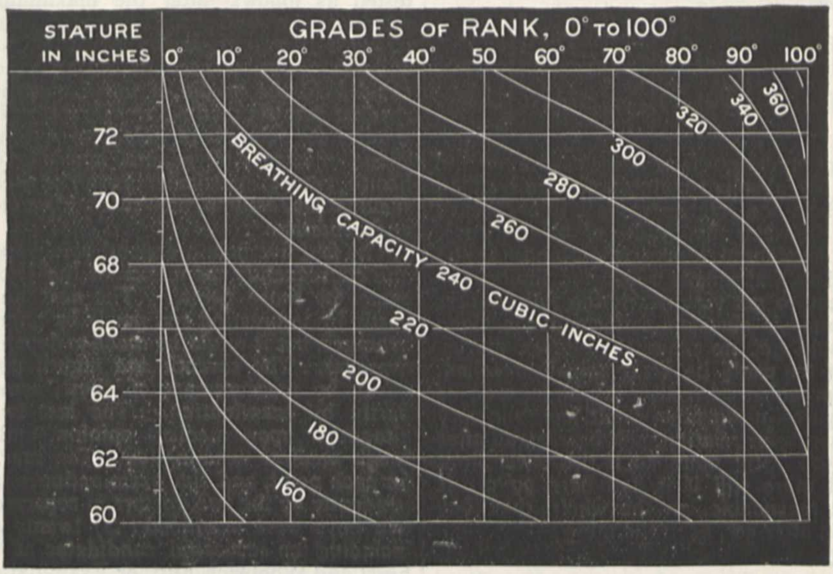


FIG. 2.

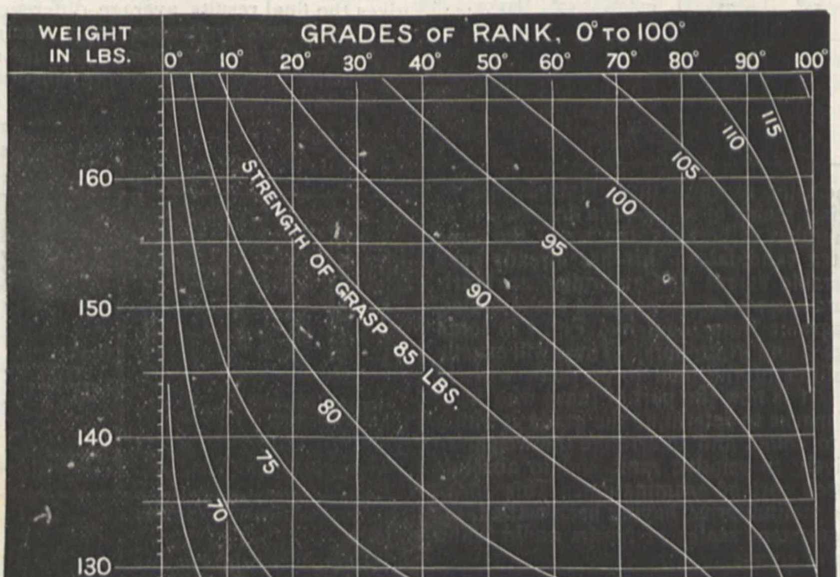


FIG. 3.

When the quality that has to be marked depends upon more than one other quality—as it may be desired to mark breathing capacity with reference *both* to weight and to stature—the simplest plan is to make a separate diagram for each inch or second inch of stature, which is quite near enough. I have, however, contrived to make a single page serve for the whole process by using a sliding strip of paper. I have submitted it for inspection, but do not care to describe it.

A strong reason for giving prominence to relative rank is that it affords the only feasible way of measuring many qualities; differences in absolute performance being inferred from rank, according to a principle now familiar to most anthropologists, by using the well-known table of the probability integral. A small table based on the latter, but of a totally different form, that I have lately more than once published (*op. cit.*, p. 205, and NATURE, vol. xxxix. p. 297). is very convenient for this sort of work. The following is a brief extract from it :—

Grades of Rank from 0° to 100°, together with the Deviations[1] *from the Mean Values at those Grades.*

Grades.....	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Deviations	−infinity	−1·9	−1·3	−0·8	−0·4	0·0	+0·4	+0·8	+1·3	+1·9
Grades.....	91°	92°	93°	94°	95°	96°	97°	98°	99°	100°
Deviations	+2·0	+2·1	+2·2	+2·3	+2·4	+2·6	+2·8	+3·1	+3·5	+infinity

Some of the consequences of marking separately the relative rank and the absolute performance are seen by the next table. Here the relative rank is in each case supposed to count between the grades of 50° and 100°. Then, if it alone is considered, a man who stands at the grade of 99° in a class that ranges within the limits of 0° and 100°, will be seen to get very nearly the full amount of ten marks, whereas if absolute performance is alone considered, he would get no more than seven marks. The full number of ten could be never actually reached, but only closely approached at some such high grade as 99·99 . . .°. The figures in this table would have run very differently if the marks for relative rank had begun after 90° and not after 50°. Still more so, if the lower limit had been 99°, and more still if it had been 99°·9. It seems to me most reasonable, on the whole, that they should usually begin after 50°, as in the table :—

Proportion of marks assigned to		Rank, 0° to 100°.				
Relative.	Absolute.	55°	75°	95°	99°	99·99 . . .°
All.	None.	1·0	5·0	9·0	9·8	10·0
½	½	0·7	3·5	6·9	8·4	10·0
⅓	⅔	0·6	3·0	6·2	8·0	10·0
¼	¾	0·5	2·7	5·8	7·7	10·0
None.	All.	0·4	2·0	4·8	7·2	10·0

The general conclusion to which these remarks lead is, that before arranging scales of marks, the first step is to measure a large number of persons who are of the same class as the expected candidates; this has already been done to a considerable extent at Cambridge, at Marlborough College, and elsewhere. Thence to make tables, and to deduce diagrams from them like Fig. 1 in some cases, and like Figs. 2 and 3 in others. These will exactly determine the qualities of the men to be dealt with, in a statistical sense. It is now the part of those who have to fix the scales of marks to determine the grade at which rank shall begin to count, and to arrange the weight to be given respectively to relative rank and to absolute performance in each sort of examination. This and a few other obvious preliminaries having been settled, the construction of consistent scales of marks would follow almost as a matter of course.

Experiments at Eton College on the Degree of Concordance between different Examiners in assigning Marks for Physical Qualifications. By A. A. Somerville.

An experiment was made at Eton in July last, with the object of obtaining information upon the following points: (1) whether it is possible to frame a system of marking for physical excellence, based partly upon Mr. Galton's system, and partly upon medical examination; (2) whether marks assigned by medical examiners would be as safe a test of excellence as those assigned, *e.g.* by examiners in English essay. The experiment was conducted as follows:—A list of points was drawn up with the help of two able medical men. These points were: (1) breathing capacity, as tested by the spirometer; (2) hearing—(3) eyesight, tested by Snellen's type; (4) strength, tested by the grip dynanometer; (5) endurance, tested as follows—after the maximum reading of the dynanometer had been obtained and registered for strength it was again (as nearly as possible) obtained, and the number of seconds during which the candidate could hold the needle of the dynanometer between this reading and the reading 10 below it was taken by a stop-watch; (6) relation of height to weight; (7) girth and shape of chest; (8) general muscular development; (9) health record, particular inquiries being made as to rheumatism, asthma, and scarlatina: (10) general aspect and condition.

The first five points depend solely upon measurement, and consequently the marks of the two doctors are the same for those points. The next point was marked, partly by impression and partly by reference to a table of averages, but it might be made to depend altogether upon averages. The seventh and eighth points were marked partly by measurement of chest, arms, and legs, and partly by examination. The last two points depend altogether upon medical opinion, and involved a thorough medical examination. Ten marks were assigned for each point, and the examination was conducted independently by the two doctors in separate rooms. Thirty-two boys were examined: (1) twenty Army Class boys, including ten successful candidates at the recent Sandhurst and Woolwich Further Examinations, two members of the Cricket XI., and two members of the Rowing Eight; (2) six other members of the XI.; (3) the remaining six members of the Eight. The following table gives the final results, average differences per cent. being calculated with reference to a maximum 50, as the marks for the first five points are the same for the two examiners. (N.B.—Letters are substituted for the names of the boys.)

Army Boys.						Six Members of the XI.			Six Members of the Eight.		
A	58½	58	K	53	56½	A	60	59	A	78¼	79¾
B	74	75¼	L	71½	77	B	59	61	B	73	71½
C	81½	83	M	57	62	C	68¼	71¾	C	76¾	78¾
D	68	69½	N	59½	65	D	77¾	71¾	D	76½	73½
E	72½	70½	O	64	70½	E	58	65¼	E	67	70¼
F	44¾	46¼	P	51½	58	F	64¾	73½	F	71¼	76½
G	65¼	68¼	Q	57	65¼						
H	66½	63½	R	60½	70½						
I	69¼	72¾	S	53¼	62¼						
J	72	76½	T	57	70½						
Greatest difference . . . = 13½						Greatest difference . = 8¾			Greatest difference. . = 5¼		
Least difference . . . . = ½						Least difference . . . = 1			Least difference . . . = 1½		
Average difference . . . = 9·5 Per cent.						Average difference . = 9·5 Per cent.			Average difference. . = 5·5 Per cent.		

Average difference for 32 boys . . . . = 4·375 for max. 50
= 8·75 per cent.

Nineteen of the twenty Army boys were subsequently examined in English essay, the essays being marked independently by two examiners, with the following results:—

A	55	50	H	15	10	N	50	25
B	45	50	I	40	60	O	70	35
C	40	35	J	65	40	P	30	65
D	20	25	K	25	15	Q	45	20
E	15	12	L	35	20	R	60	25
F	55	40	M	15	30	S	40	15
G	35	25						

Greatest difference . . . . = 35
Least difference . . . . = 3
Per cent.
Average difference . . . . = 16·7

[1] The unit by which the deviations are measured is half the difference between the performances of the persons who respectively occupy the grades 25° and 75°.

Comparing the average difference, 16·7 per cent., between the marks of the examiners in English essay, with the average difference, 9·5 per cent., for the same boys, between the marks of the medical examiners, it seems fair to conclude that the marks assigned by the latter are at least as trustworthy as those given for English essay, which may be taken as a sample subject in a literary examination.

It is hoped that similar experiments will be undertaken at other places, so that materials may be obtained for the comparison and discussion of different systems of marking, and for the construction, ultimately, of the best systems. Such experiments would be rendered all the more valuable by the introduction of fresh points of examination, and by variations in the method of assigning the marks for the different points.

NOTES.

AT a meeting of the Council of the Royal Society held on October 24, it was resolved that a Committee should be appointed to consider the desirability of raising some national memorial of the late Dr. Joule, and to take such action thereupon as they might think advisable. Sir Henry Roscoe was appointed the provisional Organizing Secretary.

THE Walker Engineering Laboratories in connection with University College, Liverpool, will be opened on November 2. The Lord President and Council of the College will entertain Sir Andrew Barclay Walker, Sir John Coode, the members of the Engineering Committee, and other distinguished guests at luncheon, served in the Walker Laboratories; and in the afternoon a public meeting will be held in St. George's Hall, at which Sir John Coode, President of the Institution of Civil Engineers, will deliver an address, and the annual distribution of medals and prizes will take place. In the evening there will be a reception at the Walker Laboratories, when the formal declaration of opening will be undertaken by the Hon. Lady Walker.

THE annual exhibition prepared by the South London Entomological and Natural History Society was opened at the Bridge House Hotel, London Bridge, S.E., yesterday, and will be open again this evening. These exhibitions have become so popular that on the last several occasions upwards of 2000 visitors have attended each evening.

DR. S. WEIR MITCHELL, of Philadelphia, has been elected President of the Congress of American Physicians and Surgeons, which will meet in Washington in September 1891.

As it is expected that the Forth Bridge will be opened for passenger traffic in the spring of 1890, it is intended that the event shall be celebrated by the holding of an International Exhibition in Edinburgh, specially devoted to electrical and general inventions and industries. The Exhibition is under the patronage of the Queen; and the Marquis of Lothian, Secretary of State for Scotland, is the President. The Vice-Presidents include the Lord Provost of Edinburgh, the Lord Provost of Glasgow, the Lord Mayor (elect) of London, Mr. Edison, and Sir John Fowler. The executive have secured a site of about ninety acres in extent, within easy walking distance of the centre of the town. On Monday, at a special meeting of the Electrical Trades Section of the London Chamber of Commerce, a resolution was agreed to, appointing a Committee to consider the conditions on which it might be advisable to take part in this Exhibition.

A CONVERSAZIONE will be given by the Geologists' Association on December 6.

A STATUE of the French chemist, Nicolas Leblanc, is about to be unveiled at Saint-Denis. Leblanc was born at Issoudun in 1753, and died in 1806. He had a manufactory at Saint-Denis.

THE following Science Lectures will be given at the Royal Victoria Hall during November:—November 5, Mr. A. P. Laurie, on "Dust"; November 12, Mr. W. Furneaux, on "The Heart, and how it beats"; November 19, Prof. Judd, "The Forge of the Blacksmith God"; November 26, Mr. J. E. Marr, "Greenland's Icy Mountains."

THE Morley Memorial College for Working Men and Women, adjoining the Victoria Hall, has begun a very vigorous life. Over 450 students have joined within three weeks of the opening day. In fact they come in with somewhat embarrassing rapidity, and volunteers (both ladies and gentlemen) are urgently wanted, both to teach classes and act as librarians. Six librarians are wanted to take one evening a week each, from 8 to 10. The library has received a valuable present from Mr. Passmore Edwards, who has given 1000 books. Others have given smaller parcels, so that the book-cases which have been provided are quite inadequate, and more are needed.

MR. WILLIAM BURGESS, the founder and proprietor of the Midland Counties Fish Culture Establishment, died on Sunday, at Malvern Wells.

LLOYD'S Agent at the Dardanelles telegraphed as follows on October 28, 9.45 a.m.:—"An earthquake was felt here on Saturday. Very little damage has been done. Sigri Lighthouse, Mytilene, destroyed, also loss of life in island."

PROF. H. G. SEELEY finds that the pubic bone, which is of large size, does not enter into the acetabulum in the Plesiosaurian genus Colymbosaurus from the Oxford Clay. In that genus, the clavicle and inter-clavicle are developed as small separate ossifications, on the visceral aspect of the large scapular arch, and hence are not usually seen.

AT the recent meeting of the Congress of German Men of Science and Physicians at Heidelberg, Herr O. Ammon submitted to the Anthropological Section some interesting results of observations he had made in Baden. These observations related to 5000 soldiers. The tall men had generally long skulls, or skulls of medium length, whereas the short men had round skulls. Most of the round-skulled men came from the Black Forest; the long-skulled usually belonged to the valley of the Rhine, and were especially numerous in towns and in the neighbourhood of the castles of ancient families. From this fact Herr Ammon concluded that the round-skulled men had been the original inhabitants of the Rhine valley, that they had been driven from it by long-skulled invaders, and that the latter had established themselves near the settlements of their victorious leaders. Having shown that there is a certain relation between the height of the figure and the shape of the skull, Herr Ammon went on to indicate the relation between fair hair and blue eyes. No fewer than 80 per cent. of the men with blue eyes had fair hair. He found also that physical growth is generally quicker in the case of the brown-eyed than in that of the blue-eyed type.

AT the last meeting of the Andersonian Naturalists' Society of Glasgow, amongst the papers read was one by Mr. R. Turner Vice-President, on the Uredineæ and Ustilagineæ. He explained the relations of these microscopic Fungi to other plants, and their position in the vegetable kingdom. They are all parasitic upon some living plant, and consist of two essential elements—spores and mycelium. The spores are very diverse, the mycelium very similar. The same mycelium gives rise to several different kinds of spores, each of these being formerly regarded as a different genus. The production of cluster-cups and of the spermagonia, with their so-called spermatia, was described. It was shown that these spermatia have been by no means established as equivalent to pollen in function. As an example of heterœcism, the life-history of *Puccinea graminis* was traced: first, the æcidiospore stage on the barberry, then the rust on wheat, succeeded by mildew, and finally, the germination of the telentospores and the production again of æcidium on barberry. Many other instances of heterœcism were adduced, and some problems suggested for the consideration of members of the Society. The Ustilagineæ were then shortly referred to, and *Ustilago segetum*, the corn-smut, given as a familar example. The paper was illustrated by diagrams, specimens, and the sections shown under the microscope.

IN a paper read before the Royal Danish Academy in February, M. Adam Paulsen gave some interesting particulars of observations made with the object of determining the height of the aurora. Two theodolites were used, the observing telescopes of which were replaced by short tubes having small holes at the eye ends and metallic cross wires at the other ends. Two of the stations were situated in the same magnetic meridian, on opposite banks of the fjord of Godthaab, at a distance apart of 5800·4 metres. The vertical circles of the two theodolites were placed in a common plane by means of observations of "blue fire" signals given at each station. Signals were also exchanged on the appearance of an aurora which it was thought possible to measure, so that simultaneous observations were secured, and it was previously agreed to direct the instruments to the base of the auroral arc. The observations at Godthaab gave heights for different auroræ ranging from 0·6 to 67·8 kilometres. A second series of observations with the same apparatus and methods was made in 1885 by MM. Garde and Eberlin at Nanortalik, near Cape Farewell, the base-line in this case being 1247·8 metres, and the values determined here were 1·6 to 15·5 kilometres. The results obtained by the staff of the Swedish International Expedition at Spitzbergen, with a base of 572·6 metres, range from 0·6 to 29·2 kilometres. These observations therefore lead to the conclusion that auroræ are by no means confined to the highest parts of our atmosphere, but that they occur almost indifferently at all altitudes. In support of this view, M. Paulsen gives accounts of several appearances of auroræ beneath the clouds and the summits of mountains. It is interesting to compare the new values with those given by previous observers. M. Flögel calculated the heights of several auroræ which appeared in the autumn of 1870, and concluded that only the very lowest parts of the aurora came at all within the limits of our atmosphere; he gave the actual limits as 150 to 500 kilometres. For an aurora on October 25, 1870, M. Reimann found a height of from 800 to 900 kilometres, and Nordenskiöld came to the conclusion that the mean height of auroræ was about 200 kilometres. On the other hand, Lemström has observed auroræ as low as 300 metres, and M. Hildebrandsson has seen auroræ in a completely clouded sky. Considering all the facts of the case, M. Paulsen inclines to believe that in the temperate zone, auroræ only appear in the higher layers of the atmosphere, whereas in the auroral zone, properly speaking, the phenomenon is generally produced in the lower layers.

IN the new Quarterly Statement issued on behalf of the Palestine Exploration Fund, it is stated that Dr. Torrance, of the Scottish Mission, has undertaken to conduct a series of meteorological observations at Tiberias for the Fund. Should Dr. Torrance be able to carry out this undertaking, the observations will, with those made at Sarona, now being published by Mr. Glaisher, and those made by Dr. Chaplin at Jerusalem, and reported in the Quarterly Statement for 1883, place the Society after a few years in the possession of materials for a fairly complete account of the meteorology of Palestine. Tiberias is 682 feet below the level of the Mediterranean, and the Society hopes that, as no regular series of meteorological observations has ever been made in such a depressed situation, the results may be exceptionally interesting. As the neighbourhood of Jericho is becoming, to some extent, a place of residence for Europeans, the Society trusts that opportunity may before long present itself for meteorological observations there also.

Symons's Monthly Meteorological Magazine for October contains a climatological table for the British Empire for the year 1888, from which we extract the following interesting details. Adelaide had the highest shade temperature, 107°·5, on December 25, and was the driest station. Winnipeg had the lowest shade temperature, −46°·4, in February, the greatest mean daily range, 22°·5, and the lowest mean temperature, 32°·3. Colombo (Ceylon) had the highest mean temperature, 80°·9, and the greatest rainfall, 101·06 inches. Malta had the least rainfall, 13·75 inches, and was the least cloudy station. The highest temperature in the sun was registered at Calcutta, 165°·4; while London holds the unenviable position of the dampest and most cloudy station.

THE *Annuaire de l'Observatoire Municipal de Montsouris* for 1889 contains a considerable amount of meteorological information. Observations appear to have been made in connection with every branch of this science, and the tables, showing the results obtained in this and former years, are well constructed; the whole being discussed by M. Léon Descroix, from an agricultural and hygienic, as well as the meteorological, point of view. In addition to this, M. Albert Lévy contributes an elaborate series of analyses of air and water, samples of which had been gathered from various sources; and Dr. Miquel his eleventh memoir on the micro-organisms that are found in them.

MR. JAMES R. GREGORY has issued a catalogue of his valuable collection of meteorites. The formation of this collection was begun nearly thirty years ago, and now Mr. Gregory finds that he can number upwards of 300 distinct "falls," "which," he says, "really places my collection among some of the largest in Europe as regards the number of falls, and in the average weight and excellence of the examples." As to arrangement, he has adopted, with a few variations, the principle of the new Catalogue of the British Museum collection in chief.

IT has been generally supposed that the mango weevil infests the pulp of the fruit, but in a letter read at a recent meeting of the committee of the Agri-Horticultural Society of Madras, from Mr. C. I. Denton, forwarding specimens of mangoes, called by the Canarese the bee mango, he states that the peculiarity of the fruit is that the stone contains a bee existing on the kernel. Specimens of the insect were forwarded by the Madras Agri-Horticultural Society to Mr. Coates, of the Indian Museum, who identified them as *Cryptorhynchus mangifera*, the mango weevil, whose normal habitation is in the pulp of the fruit, and not within the stone. The fruit sent to the Society was carefully examined, and the pulp was, in every case, free from the insect, which was only discovered when the stones from which the pulp had been removed were broken open.

A THIRD edition of Mr. Thomas Greenwood's "Free Public Libraries" is being prepared. Three years ago, when the first edition of this work was published, the total number of adoptions of the Acts during thirty-six years was only 133. At present there are 190.

A BOOK on "The Birds of Essex," by Mr. Miller Christy, is to be published by subscription. It will form the second volume of the "Special Memoirs" of the Essex Field Club. The author has been collecting materials for this work for more than fifteen years, and he says that 271 species of birds are described as having been met with in Essex—a number which has been exceeded hitherto by very few other counties.

WE have received the official report of the proceedings of the thirty-seventh meeting of the American Association for the

Advancement of Science, held at Cleveland in August 1888. The volume, we need scarcely say, contains addresses, reports, and papers of great interest. The Presidential address, delivered by Prof. S. P. Langley, is on the history of our present views about radiant energy.

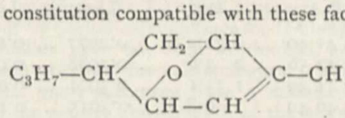
The latest issue of the Proceedings of the Royal Society of Edinburgh (Session 1888–89) includes pp. 257–320 of vol. xvi. The following are the contents:—On the relation among the line, surface, and volume integrals, by Prof. Tait; the development of diarthrodial joints in birds and mammals, by David Hepburn; electrification of air by flame, by Sir Wm. Thomson; on the placentation of the halicore dugong, by Prof. Sir William Turner; on the geographical distribution of some tropical diseases, and their relation to physical phenomena, by R. W. Felkin (with 16 plates); quaternion note on a geometrical problem, by Prof. Tait; the solubility of carbonate of lime in fresh and sea water, by W. S. Anderson.

The thirteenth part of Cassell's excellent "New Popular Educator" has been issued. It includes a good coloured plate representing the Rosegg glacier.

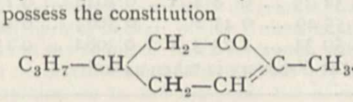
The Glasgow and West of Scotland Technical College has issued its Calendar for the year 1889–90. We have received also the new Calendar of the University College of Wales, Aberystwith.

An interesting paper on Japanese lacquer, read lately by Mr. R. Hitchcock before the Chemical Society of Washington, has been printed in the Proceedings of the United States National Museum. Japanese lacquer is the product of a tree, the *Rhus vernicifera*, D.C., which grows throughout the main island of Japan. It attains a large size, the trunks sometimes measuring a metre in diameter. It is said the tree will live for forty years, but only comparatively young trees are valued for the production of lacquer. Having yielded for several years they are cut down, the lacquer extracted from the branches, and young trees take their places. Having given an account of the chemical composition of lacquer, and described the uses to which it is applied, Mr. Hitchcock urges that it should receive more attention than has hitherto been devoted to it by manufacturers in America. "It gives a surface to wood," he says, "much harder than our best copal varnish, without brittleness. It takes a polish not to be excelled, which lasts for centuries, as we may see in the old treasures of Japan. It is proof against boiling water, alcohol, and, indeed, it seems to be insoluble in every agent known. It is the best possible application for laboratory tables. I have a set of photographer's developing trays that have been in use for more than a year, and I find them excellent and cheap. In Japan it is used for many household articles." Unfortunately, lacquer poisoning from the fresh material is a serious danger. According to Rein, the poison is a volatile acid, and Mr. Hitchcock suggests that it might be removed by a heat that would leave the lacquer uninjured.

An isomer of camphor, $C_{10}H_{16}O$, has been prepared by Drs Wallach and Otto in the chemical laboratory of the University of Bonn (*Liebig's Annalen*). This new substance is a liquid, to which the name pinol is provisionally given, possessing a very strong camphor-like odour. It is obtained by the action of hydrochloric acid upon a well-cooled mixture of turpentine oil, glacial acetic acid, and ethyl nitrite. The hydrochloric acid is gradually added in the form of a concentrated solution, and its addition is followed by the separation of crystals of the nitroso-chloride of pinene, one of the terpenes, and the formation in the solution of pinol, the new camphor. The whole is allowed to stand for about twelve hours at a low temperature to complete the precipitation of the first-named body, after which the crystals are filtered off, and the filtrate is subsequently distilled in steam. A rapid evolution of gas occurs at the commencement of the distillation, after which the pinol is quietly conveyed over in the steam. The distillate separates into two distinct layers, and the aqueous layer is readily separated by means of a funnel. The dried distillate is then freed from acetic ether by fractional distillation, and the higher boiling portion again distilled in steam. This redistilled product is similarly separated from water, dried, and finally itself subjected to fractional distillation: when the principal fraction, consisting of pinol with a small quantity of impurity, passes over between 182° and 188° C. The liquid thus obtained is found to possess in a very marked degree the odour of camphor, and it can be freed from the last traces of impurity by taking advantage of the action of bromine upon it. Bromine yields with pinol a beautifully crystalline dibromide, $C_{10}H_{16}OBr_2$. On diluting the distillate, therefore, with twice its volume of glacial acetic acid, and running in a thin stream or drops of liquid bromine, the colour of the latter rapidly disappears, and, on evaporating, splendid rhombic crystals of this dibromide are obtained. In order to recover the pinol in a pure state from the recrystallized dibromide, about a hundred grams of the latter are boiled with excess of alcoholic potash for a whole day, and the product distilled in steam, separated from water, dried with solid potash, and repeatedly fractionally distilled. Finally, pure pinol is obtained, boiling constantly at 183–84°. Analyses of this product conclusively point to the formula $C_{10}H_{16}O$, the same as that of ordinary camphor. Its constitution is proved to differ, however, from the latter body by the nature of its oxidation products. Both potassium permanganate and dilute nitric acid oxidize it to carbonic anhydride, oxalic acid, and terebic acid, $C_7H_{10}O_4$. The only possible constitution compatible with these facts is



while ordinary camphor is generally assumed on Kekulé's authority to possess the constitution



An extremely interesting fact about pinol is that its nitroso-chloride readily reacts with β-naphthylamine to form a base of the formula $C_{20}H_{24}N_2O_2$, isomeric with quinine. This is the first base of this empirical formula which has yet been artificially prepared. Solutions of both the base and its salts present similar fluorescent phenomena to those of quinine and its salts.

The additions to the Zoological Society's Gardens during the past week include a Gaur (*Bos gaurus* ♂) from Pehang, Malay Peninsula, presented by Sir Cecil C. Smith, K.C.M.G.; three Blue-crowned Hanging Parrakeets (*Loriculus galgalus*) from Malacca, presented by Mr. A. Baker; a Short-tailed Capromys (*Capromys brachyurus*) from Cuba; two Reed Buntings (*Emberiza schœniclus*), British, purchased; three Dingo Dogs (*Canis dingo* ♂ ♂ ♀), a White Goshawk (*Astur novæ-hollandiæ*), a Berigora Hawk (*Hieracidea berigora*), a Brush Turkey (*Talegalla lathami* ♀), an Australian Thicknee (*Œdicnemus grallarius*) from Australia, received in exchange.

OUR ASTRONOMICAL COLUMN.

The Natal Observatory.—The Report of this Observatory for 1888, which has recently come to hand, is a somewhat meagre one, and is chiefly occupied with the routine daily meteorological observations. The small record of astronomical work achieved may perhaps be explained by the circumstance that the Superintendent, Mr. Nevill, has recently been appointed Government Chemist and Official Assayer for Natal, that a laboratory was erected for him in the early part of the year, and that he has already commenced his official duties in his new capacity.

Of direct astronomical work the Report only records the routine work in connection with the maintenance of the system of colonial time signals; a number of observations of the zenith distances of northern stars and circumpolars both above and below the Pole, for the comparison of declinations as observed at Observatories on either side of the equator; and some progress as having been made in the observation of pairs of equi-zenith distance stars for the determination of the latitude of the Observatory. The various computations undertaken at the Observatory have been pushed forward much more zealously. These embrace the comparison of the Greenwich lunar observations for the decade 1878–87 with Hansen's lunar tables; the reduction of Mr. Campbell's observations of the lunar crater Murchison A, made at the Arkley Observatory in the years 1882–84; and the reduction of the third year's tidal observations at Durban.

THE SPECTRUM OF R ANDROMEDÆ.—Mr. Espin, who has recently discovered bright lines in the spectra of several long-period variables of Secchi's third type, has added another to the list; R Andromedæ, at the maximum just passed, showing a number of bright lines, F being very bright, so bright as to appear to project beyond the spectrum. The spectrum of the star had manifestly undergone a great change from the time when Dunér made the very thorough study of it which he has recorded in his work on "Les Étoiles à Spectres de la Troisième Classe." Five of the seven variables included in Mr. Lockyer's Species 10 of this type have now shown bright lines at maximum, whilst Gore's Nova Orionis, which should certainly be included in the same species, would make a sixth. The two stars in which bright lines have not yet been observed are R Leonis Minoris and α Herculis.

COMET 1889 *d* (BROOKS, JULY 6).—The following ephemeris is in continuation of that given in NATURE for October 3 (p. 550):—

Ephemeris for Berlin Midnight.

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
Nov. 1	23 41 40	2 32·2 S.	0·2977	0·0625	1·8
5	23 42 56	2 3·6	0·2988	0·0754	1·7
9	53 44 39	1 33·1	0·3001	0·0888	1·6
13	23 46 49	1 0·8	0·3015	0·1025	1·5
17	23 49 25	0 27·0 S.	0·3030	0·1163	1·4
21	23 52 25	0 8·4 N.	0·3046	0·1303	1·3
25	23 55 49	0 45·2	0·3063	0·1445	1·2
29	23 59 34	1 23·3 N.	0·3082	0·1587	1 1

The brightness at discovery is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *NOVEMBER* 3–9.

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

At Greenwich on November 3

Sun rises, 7h. 0m.; souths, 11h. 43m. 40·4s.; daily increase of southing, 0·5s.; sets, 16h. 28m.: right asc. on meridian, 14h. 35·4m.; decl. 15° 13′ S. Sidereal Time at Sunset, 19h. 21m.

Moon (Full on November 7, 16h.) rises, 15h. 30m.; souths, 21h. 1m.; sets, 2h. 45m.*: right asc. on meridian, 23h. 54·5m.; decl. 6° 7′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	5 8	10 37	16 6	13 28·3	6 53 S.
Venus ...	4 29	10 9	15 49	13 0·0	4 37 S.
Mars ...	2 35	8 54	15 13	11 45·3	3 5 N.
Jupiter ...	11 38	15 31	19 24	18 23·6	23 27 S.
Saturn ...	0 22	7 28	14 34	10 19·5	11 53 N.
Uranus...	5 16	10 36	15 56	13 28·0	8 37 S.
Neptune..	17 30*	1 18	9 6	4 8·4	19 15 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Saturn, November 3.—Outer major axis of outer ring = 39″·3; outer minor axis of outer ring = 5″·8: southern surface visible.

Meteor-Showers.

	R.A. °	Decl. °	
Near γ Camelopardalis...	55	71 N.	Swift.
,, the *Pleiades* ...	60	20 N.	The *Taurids*.
,, θ Ursæ Majoris ...	143	50 N.	Very swift.
From Lacerta...	346	52 N.	Rather slow.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei ...	0 52·5	81 17 N.	Nov. 4,	1 23	*m*
			,, 9,	1 3	*m*
R Canis Majoris ...	7 14·5	16 11 N.	,, 6,	17 5	*m*
			,, 7,	20 20	*m*
S Cancri ...	8 37·6	19 26 N.	,, 3,	21 22	*m*
U Ophiuchi...	17 10·9	1 20 N.	,, 5,	18 29	*m*
R Scuti ...	18 41·6	5 50 S.	,, 8,		*m*
U Aquilæ ...	19 23·4	7 16 S.	,, 9,	21 0	*M*
χ Cygni ...	19 46·3	32 38 N.	,, 6,		*m*
T Vulpeculæ ...	20 46·8	27 50 N.	,, 9,	21 0	*m*
Y Cygni ...	20 47·6	34 14 N.	,, 4,	15 40	*m*
			,, 7,	15 35	*m*
δ Cephei ...	22 25·0	57 51 N.	,, 8,	23 0	*M*

M signifies maximum; *m* minimum.

SEISMOLOGICAL WORK IN JAPAN.[1]

THE seismological work which has been accomplished in Japan is to a great extent described in fourteen small volumes published by a Society which was organized in 1880 to study phenomena connected with earthquakes and volcanoes. This Society is called the Seismological Society of Japan. An epitome of a portion of this work is to be found in nine Reports on the volcanic phenomena of Japan issued by this Association. A glance at the first few volumes published by the Seismological Society shows that the attention of its members was directed towards seismometry. For several years attempts were made to record earthquakes by using the old types of earthquake instruments, such as columns balanced on end, bowls or tubes filled with liquid, pendulums with pencils or pointers writing on paper or smoked glass. The records obtained from instruments of this order were, however, gradually recognized as being too indefinite; the instruments indicated that shakings had taken place, but they failed to measure them. All investigators recognized that to measure the movement of the earth it was necessary, while the movement was going on, to obtain a steady point or platform relatively to which the motion might be measured. By the patient labours of investigators in Japan, which have extended over many years, this has been accomplished, and we now have pendulums and other forms of instruments which for small displacements are in neutral equilibrium, so that when the frames carrying these instruments are shaken back and forth or up and down there are certain portions of them which remain at rest. From these steady points pointers project which write the movements or magnified representations of these movements upon suitably prepared surfaces.

From the simple pendulum and style, tracing its movements in sand, and costing but a few pence, elaborate instruments, embracing many new mechanical contrivances, and writing their movements with delicate siphons on continuously running bands of paper, have gradually been evolved. With the assistance of these instruments many thousands of diagrams, each of which represents in absolute measures the back and forth motions of the ground during an earthquake, have been obtained, and we now know the true nature of earthquake movement. We have learnt that, in many earthquakes which are quite perceptible and sometimes even alarming, the amplitude of motion may not exceed a millimetre, while if it reached 25 millimetres, or an inch, we might expect cities to be ruined.

The results which have flowed from a study of these diagrams are numerous and interesting. We now know that the direction of movement in any given earthquake is continually varying. At one moment a point on the surface of the earth may be moving north and south, and the next moment it may be moving east and west, while at other times it may be following a path too intricate to be easily described.

More interesting observations relate to the period and amplitude of the earth's motion, from which may be calculated the destructive power, which depends partly on the maximum velocity and partly on the suddenness of movement. Some earthquakes commence with preliminary tremors, which have been recorded with a frequency of eight or ten waves per second.

The back and forth movements of considerable amplitude which constitute the shock or shocks in an earthquake usually have a period of one or two seconds, while the ordinary back

[1] A Paper, by Prof. John Milne, of the Imperial University of Japan, Tokio, read at the British Association.

and forth movements, constituting a greater part of the shaking that is sensible, have usually a period of from three to five per second. At the end of a disturbance the wave-period is almost always very much greater than it is at the commencement or middle of a disturbance. Quite recently an earthquake was recorded in Japan, having a period of from six to eight seconds.

Observations like this are undoubtedly valuable from a scientific standpoint, but many observations are of practical importance. For example, we now know that a seismic survey can be made of any given piece of property, and as the result of such a survey it may be found that buildings erected on one side of the given area may suffer very much more than those upon the other side. Again, we know that, because in severe earthquakes the motion at the bottom of a comparatively shallow pit is very much less than it is upon the surface, buildings may be partially cut off from earthquake motion by giving them proper foundations.

In addition to the theoretical and practical results which have flowed from the study of earthquake diagrams, mechanical science has gained something from the new types of machines that have been evolved. Now we know how to make pendulums astatic. New combinations in clockwork have been invented, new governors for machinery designed, some of which have already proved themselves useful for other purposes than earthquake machinery. One machine, which has been the outcome of seismological work in Japan, and which promises to be of practical value outside the domain of seismology, is an instrument which records the vibrations in a railway train. With diagrams of these vibrations before us, we are enabled to time a train between stations, to see when it went quickly and when it went slowly, to note the duration of stoppages, to detect irregularities on a line, as, for instance, those which may occur at crossings and points, those due to a want of ballast, variations in gauge, imperfections in bridges, &c.

Seismometrical observations have not alone been confined to the observation of earthquakes proper, but observations have been made upon disturbances produced by explosions of substances like dynamite and gunpowder, the falling of heavy weights, and the moving of trains, &c. The records obtained from these experiments have perhaps taught us more about the nature of earth vibrations than we have obtained from the observation of actual earthquakes. So far as surface disturbances in superficial soil are concerned, we now know that the phenomena they present are anything but what we might anticipate as likely to occur in a theoretically elastic material.

An extremely practical subject which has received attention in Japan has been observations and experiments upon the effects produced by earthquakes upon buildings; an account of them —many of which have been successfully put into practice by builders—is now being published as the fourteenth volume of the Seismological Society's Transactions. As this particular subject is of such vital importance to the Government of Japan, who are continually erecting European structures, it is at the present time being discussed by a Committee of engineers, architects, and others, summoned for the purpose by the late Viscount Mori, Minister of Education.

The Imperial Government of Japan, by establishing in the Meteorological Department an Earthquake Bureau, and in the Imperial University a Chair of Seismology, have given an impetus to seismological investigation in general. In several parts of the country seismographs have been established, and, at between 600 and 700 stations, records are kept of all disturbances which are felt. From these records we are now able to study the distribution of seismic activity, both with regard to space and time. For instance, we now know that the greater number of shocks originate on or near the eastern coast; we know that there are many "centrums," from some of which weak, and from others strong, shocks originate; that, on the average, we feel in Japan at least two shocks per day.

Inasmuch as earthquake disturbances are relatively superficial, we may consider the area of disturbance as a very fair estimate of seismic effort. In 1885 the land area shaken was about 660,000 square miles, and in 1886 it was about 562,000 square miles.

Here we have the commencement of a series of interesting figures which may, perhaps, be related to a heat-gradient—to the fluctuations in the flow of the Black Stream, or to something not yet thought about.

Hitherto, when studying earthquakes in relation to meteorological changes, the position of the moon, the seasons, &c., we have been compelled to take very imperfect catalogues of shocks which have originated from "centrums" as independent of each other as most volcanoes are of each other. Now we are getting material which will enable us to study a group of earthquakes which have come from a given origin. Disturbances in the ocean have not been overlooked, and the waves which Japan has sent to America, and those which America has returned, have been carefully investigated, and average depths of the ocean along several lines have been determined. In all instances it appears that the depths calculated from the transmission of a sea-wave are a little less than the depths obtained by averaging the soundings. Does this mean that there is an incompleteness in the formulæ which have been used? or does it mean that sailors have allowed their line to run a little after striking bottom?

Other investigations which have been made relate to the effects produced by earthquakes upon the lower animals; and one investigator, Prof. Sekiya, at one time kept pheasants purposely to observe their behaviour at the time of an earthquake. A conclusion arrived at is that pheasants, geese, horses, and other animals often show decided symptoms of alarm a few seconds before the occurrence of a severe shaking. The reason of this probably is that they are more sensitive to preliminary tremors than human beings.

The relationship between volcanic phenomena, earth currents and magnetism, and earth disturbances, has not been unnoticed, while mathematicians and physicists have had new problems suggested to them respecting the determination of earthquake origins, the depth of "centrums," the force required to cause destruction like the shattering and overturning of structures, the propagation of surface waves, &c.

The observations of late years respecting the destruction of submarine cables have led Mr. Forster, of Zante, to the opinion that certain earthquakes are the immediate result of submarine landslips, and suggested to Japanese observers that something might be learnt by periodical soundings made along the Japanese shores. Volcanoes have not been overlooked, and many new facts have been obtained for vulcanologists. For instance, we now know that many volcanoes have a definite curvature dependent upon the density and strength of the materials of which they are built, and given any two of these three quantities—curvature, density, and strength—we may determine the third; thus, as pointed out by Mr. Becker, of the United States Geological Survey, may not the shape of lunar volcanoes, with an assumption as to the density of the material of which they are composed, lead to an opinion as to the materials out of which they are made?

About the extremely minute movements called earth tremors, which are probably in all places and at all times to be observed, much has been done. For three or four years, by a specially-contrived instrument, these have been recorded automatically. The investigation of these records has led to the conclusion that earth tremors are closely connected with wind. When a heavy wind is blowing, tremors are usually strongly marked, but the more curious result is that they are often very marked in calm weather. An inspection of the tri-daily weather maps published in Japan shows that on these occasions a heavy wind is blowing against high mountains 60 to 200 miles distant. From this it appears that earth tremors outrace storms inland, much in the same way that small waves outrace storms upon the ocean. Insomuch as earth tremors accompany heavy barometrical gradients, and these are related to the outpouring of fire-damp in our mines, it would appear a legitimate investigation to study the behaviour of a tromometer, say in the Newcastle area, in relation to the escape of underground gas. Hitherto I believe that investigators in Great Britain have been observing seismometers rather than tromometers.

With these few remarks respecting the general nature of investigations which have been made and are yet going on in Japan, I will enumerate a few phenomena which require explanation, and suggest a few investigations which have yet to be undertaken.

Large earthquakes are usually preceded by a series of short-period vibrations. These vibrations have an amplitude of about one-tenth of a millimetre, and six to ten of them occur per second. With a seismograph giving great multiplication, it is probable that still smaller and more rapidly recurring waves may be recorded. These hitherto unseen portions of an earthquake may be the cause of the sound-phenomena of earthquakes, and the movements which, although not felt by human beings, alarm the lower animals. Why are the larger movements of an earthquake preceded by tremors of this description?

The rate at which earthquake motion is propagated is sometimes very high. From Toronto to Ontario in the Charleston earthquake of 1886 the velocity was over 15,000 feet per second, whilst at the destruction of Flood Rock, in 1885, velocities of 20,000 feet per second were observed.

As was suggested by Sir William Thomson, observations like these may mean that the rigidity of the Earth is greater than that of surface rocks. If it is so, then, as Sir William suggested, extended observations may lead to the determination of these rigidities. In connection with this, it must be remarked, that, both for artificial as well as for natural disturbances, the velocity of transmission varies with the intensity of the initial disturbance, the nature of the medium, and it becomes less as a disturbance radiates. General Abbot, however, in one instance noted an increase in velocity as a disturbance radiated.

What is perhaps closely connected with the above, or what at least is analogous, is the fact that at a given station the wave-period becomes longer as a disturbance dies out, and it also becomes longer as a disturbance radiates. One inference to be drawn from this may be that long-period earthquakes originate at a distance, a wave flattening out as it radiates, pretty much as it does in the ocean; but Sir William Thomson has suggested that a long-period disturbance may be related to the dimensions of the focal cavity. Recently, in Tokio, an earthquake having a period of about eight seconds was observed. For seismographs to record this, they must have been tipped from side to side.

Another point of interest is that for *small* displacements period increases with amplitude, but after a certain amplitude is reached the period is either constant or only increases very slowly. This observation apparently harmonizes earth motions with those of ideally elastic bodies.

Another set of interesting observations is the relationship between normal and transverse movements. At a short distance from an origin the normal movement distinctly outraces the transverse motion, but when the amplitude of the normal motion has been decreased until it practically equals that of the transverse motion the separation between the movements is *nil*. A curious feature, especially in normal movements, is the fact that near an origin the movement inwards or towards the source of the disturbance is greater than it is outwards; further, as a normal wave radiates it may be observed to gradually break up into two waves, in consequence of which a diagram taken at one station may be very different from one taken at another.

In conclusion, I will point out a few observations which, on account of the expense they involve, the difficulty of obtaining observers, &c., have not, or at least only partially, yet been undertaken:—

1. *Velocity of Earthquake Propagation.*

The importance of determining the velocity of earthquake propagation has already been noted, and it has been shown that on account of the difference in the aspect of diagrams at neighbouring stations it cannot be done on a small area. The Imperial Telegraph Department of Japan is at the present moment giving its assistance in this matter, but as so much depends upon telegraph operators who have duties to attend to, a number of specially constructed timepieces are required.

2. *A Gravity Observatory.*

Many years ago Sir William Thomson suggested the importance of an observatory to determine whether there are changes in the value of G. In Japan we have a country where superficial and probably subterranean and suboceanic changes are taking place very rapidly. Last year the greater portion of a mountain was blown away, and an area measuring 12 miles by 10 miles was, in ten minutes, or less, buried from 30 to 100 feet beneath a stream of earth and rock. What is going on beneath our volcanoes we do not know, but every now and then they pour out volumes of solid matter. Along the coast we have a sharp and deep depression, perhaps the deepest on the face of the globe. Do submarine landslips take place along this coast, as they most certainly have done in other parts of the world?

Lastly, may there not be an apparent change in the value of G, dependent upon the time at which the observations have been made? At certain seasons tremor storms are very marked, and may not their minute movements have a cumulative effect upon the small swings of pendulums used in gravity determinations. Pendulum observations of the ordinary kind have been made in many parts of Japan, from the summit of Fujiyama to the Bonin Islands, but neither in Japan nor in any other portion of the world—so far as the writer is aware—has a pendulum been swung at a given point for a considerable period of time.

3. *Observations on Submarine Changes.*

Many of the Japanese earthquakes originate near the deep submarine depression which has been spoken about. If any of these are due to suboceanic land slides or sinkings, as have been observed in the Mediterranean and in the Atlantic, such changes might be noted by periodical soundings, and perhaps even by the records of tide-gauges.

4. *Magnetic Observations.*

Dr. Edmund Naumann called attention to the fact that nea. certain Japanese volcanoes there have been abnormal changes in declination. The volcanic rocks of Japan are exceedingly magnetic, and they are of enormous extent. Many of the rocks in Fujiyama will deflect an ordinary compass needle through 180°. Now, as these rocks are sometimes hot and sometimes cold, whilst at the time of an eruption, and possibly at other times, there are subterranean shiftings in the positions of these magnetic masses, could not these changes be noted by establishing a magnetic observatory on the side, say, of a recent volcano like Fujiyama?

5. *Bending of the Earth Crust due to Tidal Load.*

Some years ago, in conjunction with Mr. John Stoddart, Manager of the Takashima Colliery, the workings of which extend a considerable distance beneath the Pacific Ocean, the writer, by means of a simple apparatus, endeavoured to measure any movement of the roof of the mine which might be occasioned by the rise and fall in the tide. Unfortunately, the apparatus together with other instruments were lost by a complete subsidence in one portion of the workings, and these observations, if they are of any value, have to be recommenced.

6. *Tromometric Observations.*

A continuous automatic observation of earth tremors has hitherto only been made in Tokio. Might not these observations be continued in a coal-mining region to determine whether these minute earth movements, which are certainly connected with barometrical changes, hold any relation to the outflow of fire-damp.

7. *Earth Currents.*

Have earth currents any relationship to earth tremors and to earthquakes? Earth currents are produced when the ground is shaken by an explosion of dynamite, but this might be due to the increase or diminution of pressure in the earth plates causing changes in chemical activity. Have earth currents been observed in the vicinity of an active volcano, or in relation to some large earth fracture?

8. *Earth Oscillations.*

In Japan the borings of marine shells, 10 or 12 feet above high-water mark, in very soft rock which easily disintegrates, shows that there has been a rapid movement in the earth's crust relatively to sea-level. Is it likely that this could be measured, and the axis of the movement be determined, by repeating, at intervals of twelve months, the levelling of two lines running as nearly as possible at right angles to each other? It has been suggested that, if the movement is rapid, say 1 inch per year in a large bay like that of Tokio when the rise and fall of the tide is small, the isochronous observation of records obtained under approximately similar conditions from a series of tide-gauges, the level at each gauge relative to some fixed point on the neighbouring rocks being known, might furnish data which would be of value in the measuring of earth oscillations.

These, then, are a few suggestions respecting work which might perhaps be better carried out in Japan than in most other countries. They are laid before this meeting for the purpose of obtaining an opinion as to how far they may be regarded as legitimate subjects for investigation; and if the members of the meeting will freely criticize them, or suggest other lines of research, a benefit will be conferred upon workers in Japan, and on all who are interested in earth physics.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Smith's Prizes have been adjudged as follows:—To H. F. Baker, B.A., of St. John's College, for his essay entitled "The Complete System of 148 Concomitants of Three Ternary Quadrics, in terms of which all others are expressible as Rational Integral Algebraic Functions, with an Account of the Present Theory of Three such Forms." To J. H. Michell, B.A., of Trinity College, for his essay entitled "The Vibrations of Curved Rods and Shells." The adjudicators place the two names in alphabetical order, not desiring to assign precedence to one essay over the other. Mr. Baker and Mr. Michell were bracketed Senior Wranglers in 1887.

SCIENTIFIC SERIALS.

Revue d'Anthropologie, troisième série, tome iv., cinquième fasc. (Paris, 1889).—A chart of the colour of the eyes and hair in France, by M. Topinard. The author explains at length the methods he has adopted in elaborating the great mass of materials supplied him by the 2000 collaborators, at home and abroad, who responded to his appeal when, in 1886, at the suggestion of Dr. Beddoe, he undertook to examine the relations between the colour of the hair and the eyes among different peoples. In this chart of the general distribution of the blonde and the brunette types in the several departments of France, the variations between the extremes of these elements are clearly indicated by various shades from white to black. We are thus able at a glance to observe that while France generally admits of being divided into two great zones, the one occupying the north-east and the other the south-west of the French territories, each includes one or more departments in which an opposite type crops up. In most instances this anomaly may be accounted for by the early history of the invasions and foreign settlements to which France was subjected before its various parts were welded together. Thus it appears that the blonde races entered both by land from the Low Countries on the east, and by sea from Belgium, the Franks and Burgundians having invaded the country on one side, while Franks, Saxons, Normans, and Britons advanced on the opposite side. Similarly, men of the brunette type entered France on one hand from the Ligurian coasts of the Mediterranean, and on the other from Iberia. A curious fact is mentioned by M. Topinard—that, while the blonde races followed the left bank of the Rhone valley, the dark races advanced along the Bay of Biscay as far as the Vendée, where the two came into contact, the latter being soon repulsed, and forced to follow the course of the Loire as far as Blois. By a comparison of the various tables it appears that some departments show a predominance of one colour in relation to the eyes, and an opposite one in regard to the hair. There is, however, only one department which can be classed as being blonde in relation to the hair and brunette in regard to the eyes. This, and various other anomalies, presenting great interest from an ethnological point of view, have been considered by M. Topinard with his usual ability, and although he treats only of the relative distribution of colour in the eyes and hair among the French people, his paper is a model for similar investigations, and worthy the gratitude of all ethnological inquirers.—Kashgaria, and the passes of Tian-Shan, by Dr. N. Seeland. In this concluding number of his contributions to our scanty knowledge of this part of Turkestan, the writer describes his visit to the city of Aksou, lying on a plain 3500 feet above the level of the sea, and not far from the River Aksou-Daria.—The Stone Age in Italy, by M. P. Castelfranco. This is a concise, yet comprehensive, description of the human and other osseous remains, and of the various objects found in the Palæolithic stations of Italy in recent years, giving all necessary details concerning the times of discovery, and the character of the several caves and stations where they occurred. As yet there is no evidence of the existence of man in Italy in the Tertiary age; his appearance there being apparently not earlier than the close of the Quaternary, and contemporaneous with *Ursus spelæus*. The period of the Cave-dwellers must, however, have coexisted with certain phases of civilization, since, in Liguria more especially, jade arms are found blended with bone and stone weapons and other implements in the graves of these Italian Troglodytes, whose remains closely resemble those of the Cro Magnou men. Thus far, the finds in Italy, which the author describes at great length, do not admit of being referred with any exactitude to the successive periods of the Palæolithic Age recognized elsewhere. The value of M. Castelfranco's treatise is increased by an appendix of bibliographic notices, which will be found of great use to the English reader.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 21.—M. Des Cloizeaux, President, in the chair.—Researches on the relations existing between the physical characters of plants and the proportion of elements of fertility in the soil, by M. G. Ville. The composition of the soil influences colour, size, weight, general aspect, the amount of carotine, and that of chlorophyll. In plants with nitrogen predominating (hemp, wheat, &c.), least carotine is found when a manure without nitrogen has been used; in those with potash predominating (potato, vine), when potash has been suppressed. The variations in chlorophyll correspond to those of carotine. For each plant there is a time when the contrasts of colour reach their maximum. M. Ville shows, in a diagram, how a hemp plant varied with different manures.—Observations of Barnard's comet (September 2, 1888) 1889, I., made with the 0·38 m. equatorial of Bordeaux Observatory, by MM. G. Rayet and Courty, by M. G. Rayet.—On a method of measuring the flexure of a mural circle, independently of the telescope, by M. Périgaud. A rigid rod, the length of the diameter, is attached to the axis, so as to be able to turn round it and be fixed in any position. Divisions traced on it, near the ends, are examined through two microscopes 180°, apart. After one reading, the circle is turned 180°, and a second reading taken.—On the invariants of a linear and homogeneous differential equation, by M. Mittag-Leffler.—On surfaces of which the ds^2 is reducible in several ways to Liouville's form, by M. G. Kœnigs.—On the simultaneous synthesis of water and hydrochloric acid, by MM. P. Hautefeuille and J. Margottet. Mixtures formed by adding chlorine to the gaseous elements of water, or oxygen to the elements of hydrochloric acid, were exposed to the electric spark. If the volume of chlorine is more than half the hydrogen, the ratio of the numbers of equivalents of water and hydrochloric acid formed is always less than unity, and it diminishes rapidly with increase of the chlorine; when it is double the hydrogen, the water ceases to be appreciable. When oxygen is added to the elements of hydrochloric acid, the above ratio is always less than unity, but varies only between narrow limits, in increasing the ratio of volumes of O and H from $\frac{1}{4}$ to 3.—On the existence of sulphate of phosphonium, by M. A. Besson. Dry gaseous phosphoretted hydrogen passed into sulphuric acid kept at 20° to 25° below zero, is largely absorbed, the liquid becoming syrupy. The product is then pretty stable, and may be kept at a few degrees below zero. On decanting, a white very deliquescent crystalline mass is found, which seems to be sulphate of phosphonium. Thrown into water at ordinary temperature, it is decomposed with a crackling noise, liberating phosphoretted hydrogen without reduction of sulphuric acid. The white mass, as it rises to the ordinary temperature, decomposes with reduction of sulphuric acid and oxidation of phosphorus.—On the action of ammoniacal sulphate of copper on sorbite and on mannite (a reply), by M. Guignet.—On the *rôle* of ammonia in the nutrition of the higher plants, by M. A. Müntz. He finds, by experiment with bean, maize, hemp, &c., that such plants can directly absorb ammoniacal nitrogen by their roots; the nitrification of ammonical manures not being indispensable to their utilization.—On the mucous canals of Cyclopterides, by M. F. Guitel. There are three systems of these, two maxillo-opercular (one on each side), and one median, with symmetrical halves. Each half of the latter system (in *Liparis*) has eleven orifices, and each maxillo-opercular system seven, making thirty-six. Full details are given.—New contributions to the geological study of the Lower Alps, by M. W. Kilian. In the Upper Jurassic epoch there seem to have been a series of coralligenous reefs in the position of the mountains of Ubaye; and a shallow part of the Oolitic sea is here indicated. The eastern limit hitherto assigned to the Lower Cretaceous sea should be put back considerably.—On a new way of preparing oxamide and oxamic acid, by M. E. Mathieu-Plessy. Oxalate of ammonium is introduced into fused nitrate of ammonia, and the whole kept four hours between 170° and 175°.—Attempt to produce an iodide of nitrogen photometer, by M. G. Lion. This is based on comparison of the volumes of nitrogen produced in equal times, by the light examined, and by a light standard.—Volumes on the life and works of D'Alembert (Bertrand), and on the flight of birds (Marey), &c., were presented.

BERLIN.

Meteorological Society, October 8.—Dr. Vettin, President, in the chair.—Prof. Assmann spoke of his meteorological experiences on the Sentis (Canton Appenzell). In order to be able to reply to the objections which have been raised in many quarters against his aspiration-thermometer, he submitted this instrument, in the form which it has now assumed, to a testing under the most unfavourable conditions. The instrument ought to record the temperature of the surrounding air alone even when exposed to the most intense solar radiation, and not be in any way affected by the latter. In order to determine whether it conforms to the above requirement or not, he lived for four weeks on the Sentis, and found, as the outcome of several thousand experiments, that the instrument thoroughly acts up to what is required of it, when its form, as originally exhibited to the Society, is modified so that a constant current of air is drawn through the metallic tube which surrounds the thermometer by means of an arrangement of clock-work. This clock-work is attached to the upper end of the tube, and drives a fan with considerable velocity, thus forcing the air out of the tube at the top and drawing it up from the lower portion of the tube; by this means a rapid constant current of air is kept streaming over the bulb of the thermometer. He had previously satisfied himself by direct experiments with hot water that the indications of the thermometer are not in any way affected, even when the temperature of the metal tube which surrounds it is raised to 20° C. above that of the surrounding air. On the Sentis, however, the direct solar radiation never raised the temperature of the metal tube by more than 3° C. The solar radiation, measured by means of a blackened thermometer *in vacuo*, was 33° C., while at the same time the temperature of the air was 3° C. Simultaneously with the speaker's own measurements of temperature on the Sentis, Dr. Siegfeld, in Munich, made similar measurements with a similar instrument in a balloon floating at a height equal to that of the Sentis peak; and further, at the same time, a corresponding set of experiments were carried on in a balloon at Berlin. It is his intention to publish an account of these interesting experiments in some scientific treatise which will appear shortly. Dr. Assmann further described the arrangement of the meteorological station on the Sentis, his testing of the instruments which it contains, and a prolonged series of very interesting observations on thunderstorms, which were of daily occurrence: these storms were remarkable for the suddenness of their development, and the very striking cloud-formations by which they were accompanied, the latter being recorded photographically. One of his most striking experiences was of a fall of hail which lasted for an hour and a half, the hail falling from a cloud which was not more than 350 metres above him. He concluded his address by a very full description of a series of observations on cases of St. Elmo's fire which were characterized by acoustical rather than optical phenomena.—Lieutenant Gross gave a short account of the balloon journey which he made in order to determine, simultaneously with the observations on the Sentis, the temperature of the air in the higher regions above Berlin. The balloon reached an elevation of 3600 metres, at which height the temperature recorded was − 7° C., the temperature at the earth's surface being at the same time +25° C.—Dr. von Dankelmann exhibited a series of curves of temperature and air-pressure which had been registered in Cameroon by means of self-recording instruments.

Diary of Societies.

LONDON.

FRIDAY, NOVEMBER 1.

PHYSICAL SOCIETY, at 5.—On Electrifications due to the Contact of Gases with Liquids: J. Enright.—On a New Electric Radiation Meter: W. G. Gregory.—On a Physical Basis for the Theory of Errors: Dr. C. V. Burton.

GEOLOGISTS' ASSOCIATION, at 8.—On Metal Mining: Upfield Green.

SATURDAY, NOVEMBER 2.

ESSEX FIELD CLUB, at 7.—Exhibition and Remarks thereon.—Delegate's Report of the British Association Conference of Local Societies at Newcastle-on-Tyne: William White.—On Collecting Diptera; with Remarks on the Diptera of Epping Forest: E. Brunetti.—Notes on the Pleistocene Deposits at Felstead, Essex: J. French.

MONDAY, NOVEMBER 4.

ROYAL INSTITUTION, at 5.—General Monthly Meeting.

TUESDAY, NOVEMBER 5.

ZOOLOGICAL SOCIETY, at 8.30.—On New Indian Lepidoptera, chiefly Heterocera: Colonel C. Swinhoe.—On the Genus Urothoë and a New Genus Urothoides: Rev. Thomas R. R. Stebbing.—List of Birds collected by Mr. Ramage in St. Lucia, West Indies: P. L. Sclater.—On the Relations of the Fat-bodies of the Sauropsida: G. W. Butler.

UNIVERSITY COLLEGE BIOLOGICAL SOCIETY, at 5.—The Defence of Plants against Animals: F. Ernest Weiss.

WEDNESDAY, NOVEMBER 6.

GEOLOGICAL SOCIETY, at 8.—Contributions to our Knowledge of the Dinosaurs of the Wealden, and the Sauropterygians of the Purbeck and the Oxford Clay: R. Lydekker.—Notes on a "Dumb Fault" or "Wash-out" found in the Pleasley and Teversall Collieries, Derbyshire: J. C. B. Hendy. Communicated by the President.—On some Palæozoic Ostracoda from North America, Wales, and Ireland: Prof. T. Rupert Jones, F.R.S.

ENTOMOLOGICAL SOCIETY, at 7.—Notes on the Entomology of Iceland: Rev. Dr. Walker.—Additional Notes on the Genus Hilipus: Francis P. Pascoe.

UNIVERSITY COLLEGE CHEMICAL AND PHYSICAL SOCIETY, at 4.30.—The Nature of Electricity: Dr. A. H. Fison.

THURSDAY, NOVEMBER 7.

LINNEAN SOCIETY, at 8.—On a Collection of Dried Plants chiefly from the Southern Shan States, Upper Burma: Colonel H. Collett and W. Botting Hemsley, F.R.S.

CHEMICAL SOCIETY, at 8.—The Isolation of a New Hydrate of Sulphuric Acid existing in Solution: S. U. Pickering.—Further Observations on the Magnetic Rotation of Nitric Acid, of Hydrogen Chloride, Bromide and Iodide in Solution: Dr. W. H. Perkin, F.R.S.—On Phosphoryl Trifluoride: T. E. Thorpe, F.R.S., and F. T. Hambly.—On the Acetylation of Cellulose: C. F. Cross and E. Bevan.—On the Action of Light on Moist Oxygen: A. Richardson.—Anhydracetophenonebenzil and the Constitution of Linius lepideus: Drs. Japp, F.R.S., and Klingsman.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Viking Age, 2 Vols.: P. B. du Chaillu (Murray).—Alternative Elementary Chemistry, 2nd edition: J. Mills (Low).—Charts of the Constellations: A. Cottam (Stanford).—The Birds of Oxfordshire: O. V. Aplin (Oxford, Clarendon Press).—Topics in Geography: W. F. Nichols (Boston, Heath).—An Introduction to Chemical Science: R. P. Williams and B. P. Lascelles (Ginn).—Five Months' Fine Weather in Canada, &c.: Mrs. Carbutt (Low).—Survey of India Department Report, 1887–88 (Calcutta).—Science of Every-day Life: J. A. Bower (Cassell).—The Teacher's Manual of Geography: J. W. Redway (Boston, Heath).—Elementary Physics: M. R. Wright (Longmans).—Experimental Science: G. M. Hopkins (Spon). Special and Atomic Energy, 2 parts: F. Major (Eyre and Spottiswoode).—Introductory Lessons on Quantitative Analysis: J. Mills and B. North (Chapman and Hall).—Elements of Physiology: J. H. E. Brock (Chapman and Hall).—Solutions to the Questions set at the May Examinations of the Science and Art Department, 1881–86, Machine Construction: H. Adams (Chapman and Hall).

CONTENTS.