THURSDAY, DECEMBER 26, 1901.

FIRE PREVENTION.

Publications of the British Fire Prevention Committee, Vols. i to iii., 1898 to 1900. (1, Waterloo Place, S.W.)

THE subject of Fire Prevention is somewhat curiously manifold. The best mode of securing permanent peace is to prepare continually for war, and the most likely way to prevent fire is to have every means of combating it in perfect readiness, so that at the earliest symptom of danger immediate steps can be taken to reduce the temperature. To secure this end knowledge is necessary, and where there is real knowledge there is not much difficulty.

Buildings should be constructed of such materials and in such forms as experience has proved to be necessary for the safety of the contents, whether merchandise or persons, and at the same time the cost must be kept within such reasonable limits that the responsible public or private authority may be justified in rigorously enforcing the regulations laid down for the general good.

To construct a building, as is generally the case, without any regard to its safety from fire, and after its completion to call in an expert to arrange for its protection, is a most expensive and unsatisfactory proceeding.

All the arrangements for its protection should be shown on the original working drawings before a single brick is laid, or even the foundation prepared; and, where this is done with knowledge, no expense whatever, or, at worst, a minimum of expense, will be incurred.

For the protection of merchandise a building can be so divided by fire-proof partitions that the contents of any compartment in it may be burnt out without affecting any other compartment, even when no external aid for extinguishing a fire is available, and this is all that can be done in the way of construction; but there is no difficulty in doing it.

For the protection of life a building should be so arranged that there shall be clear and simple modes of immediate exit within the time necessary for safety in accordance with the nature of the contents.

For instance, in a carpenter's workshop in which no artificial heat is used, and the light is supplied by electricity, a large number of persons can have plenty of time to pass out by ordinary doors in case of emergency, and the same may be said of a warehouse not containing inflammable stock; but it is a very different matter where volatile oils or explosives are stored and manipulated; or where, as in a theatre, large numbers of persons are closely packed in the immediate neighbourhood of scenery or appliances likely to burst forth in flame, and produce volumes of poisonous smoke within a few minutes. It is much more difficult to protect life than property; but it is by no means impossible within reasonable limits. Both subjects may be considered separately.

Of late years much attention has been paid by architects to the materials which they use, and the result has been that new materials have been invented, and improved application of old materials adopted.

The introduction of certain metals, impossible in former years, but now easily available, was a great advance, and the protection of these metals with concrete, plaster, and other substances, has been a still further improvement, but there is something else to which attention should be called.

It may be a little invidious, and in some respects unfair, to speak disparagingly of those who have gone before us, and every allowance must freely be made for them; but to a practical student now observing buildings of one or two generations ago, it certainly does appear that in the great majority of cases there can have been no effort at adaptation.

In all our large centres of commerce and manufacture hundreds of buildings may be found which were originally quite unsuitable to the purposes for which they were used; and, even after expensive alteration and dangerous patching, are by no means either economical or convenient for profitable working at present.

Latterly, however, architects seem to have studied the business of their clients, and on every side we see evidence of thoughtful, practical adaptation for the requirements of every kind of service—private houses, offices, warehouses for all the numerous descriptions of stock, factories for all the various methods of mechanical engineering, placing the fires, the forges, the lathes, the stores and everything else that is necessary in the relative position most suitable for speedy and economical work, and churches and other buildings in which large numbers of persons are assembled. There is still room for improvement in theatres; but there are signs that this is coming or will come in time.

The great hotels and clubs of the present day compared with those of past generations, or even those of twenty years ago, are as palaces to pig-sties, and this improvement is entirely the work of architects who have studied the requirements of their employers.

In the year 1882 the Secretary of State for the Home Department (it is supposed at the special desire of her late Majesty, Queen Victoria) requested from the Metropolitan Board of Works, "A report from the Fire Brigade as to the actual condition of the London theatres in respect of security from fire, stating what additional precautions they think necessary to be taken to prevent loss of life in case of conflagration;" and in the summer of that year, Captain Shaw, the chief officer of the Brigade, made a detailed report on each of the forty-one theatres then existing.

This report is much too long and too full of detail for insertion here; but a few extracts from his "general remarks" at the end may be instructive.

"In dealing with the exits from theatres it is necessary to call attention to the perversity of ingenuity which characterises the arrangements of several houses for getting away. In some cases, where a whole building intervenes between the auditorium and the street, and the space actually existing is more than ample for the escape of an audience, every exertion seems to have been used to make the passages, corridors, landings and stairs as complex and tortuous as possible; and, having done this, then to obstruct them and make them still more inconvenient by pay-boxes, cloak-rooms, barriers, refreshment-counters, single or double steps and partial walls, thus causing nightly confusion and annoyance to the visitors, and adding, moreover, very considerably to their risk in case of panic from fire or any other cause."

"In many cases the first point of actual safety reached by the audience is the street door into the open air, although the removal of a few walls, barriers, pay-boxes and other obstructions, now wrongly placed, would make it 50 or 60 feet nearer the seats, and thus add greatly to the convenience and safety of the visitors."

"In some theatres the attendants seem to spend the greater portion of their time in showing visitors the way."

"I should not recommend a licensing authority to permit the existence of any exit requiring a guide, and I greatly doubt whether any should be permitted which could not be adequately described in half a-dozen words."

"For the safety of an audience it would be most important that the construction of simple separate exits should be encouraged. I should prefer to see them leading into the open air; but the point is not so much where they should lead, as that they should lead by a short route to a place of safety."

"In the event of a panic from smoke or fire or any other cause, the essential conditions of safety for an audience are light and air."

"In the event of a panic, the first steps to be taken by those responsible for the safety of an audience should be to turn on all possible lights, to drop the heat-proof curtain, and to open the smoke-outlet over the stage."

Captain Shaw gives the numbers which could be safely accommodated in the several parts of each theatre, and he makes the total number for the forty-one theatres of that date 53,326.

It is to be regretted that this report cannot be given in full; but it may be hoped that the few selected extracts will supply a general indication of its purport.

Of late years a society has been formed under the title of "The British Fire Prevention Committee," the main object of which is stated to be: "To direct attention to the urgent need for increased protection of life and property from fire by the adoption of preventive measures."

This is an admirable idea, and cannot fail to effect good practical results. The society is altogether private, and has no public authority or sanction whatever, but it is none the worse for this, and it is supported by many persons of influence and practical knowledge, including the late superindenting architect of the London County Council, and will undoubtedly be the means of calling special attention to the paramount importance of *preventive* measures, while it does not in any way ignore the absolute necessity for means of dealing promptly and effectively with catastrophes which have not been prevented.

A thoroughly efficient fire brigade can certainly do much, but, however perfect the supply and distribution of water, or the mechanical appliances and personal intrepidity and skill of the firemen may be, still the safety of any great city, and more particularly of any mercantile city containing a great amount of massed property, must eventually depend on the mode in which its buildings are constructed, and the property within them classified with special reference to risk of fire.

According to a paper read by Sir R. Giffen some years ago at the Royal Statistical Society the wealth of this country was estimated by that distinguished financial authority as 11,500,000,000*l.*, or eleven thousand five hundred millions sterling, and Sir John Lubbock, about the same time, stated that a sum of nearly eight thousand millions was passed into the London Clearing House in one year.

Both these amounts would now be considerably increased; indeed, a recent number of the *Saturday Review* gives the annual amount now passing through the London Clearing House at more than eleven thousand millions sterling; but how closely these figures represent the actual value of property liable to be consumed by fire it is difficult to say.

A consideration, however, of the deliberate statements made by such high authorities as these must show beyond doubt that this country contains an amount of material wealth unparalleled in history, and common sense indicates that it is a national duty to preserve it as far as possible from diminution or annihilation.

EMERITUS.

CUNEIFORM DECIPHERMENT.

Assyrian Language. Easy Lessons in the Cuneiform Inscriptions. By L. W. King. Pp. xv + 216. (London: Kegan Paul and Co., Ltd., 1901.) Price 3*s.* 6*d.* net.

MR. KING'S modest little volume on the Assyrian language will, we believe, be welcomed by many who are not Assyriologists, because it contains a brief but lucid exposition of the principles upon which the decipherment of Assyrian is based. It is now many years ago since the first labourers in the stubborn field of Assyriology produced their first fruits, and as two generations of men have grown up since that time the early labours of Rawlinson, Lassen, Hincks, and Norris have become well nigh forgotten. Mr. King's book is, as its title signifies, intended to help beginners in the study of Assyrian to master that difficult language, but it is good to note that he also means the beginner to come behind the scenes and to see, not only the results, but how the results have been arrived at. In these days we are so much accustomed to see translations of cuneiform documents in English, French and German that it is hard to realise that less than fifty years ago the phonetic values of a great number of Assyrian characters were unknown.

The first chapter deals with cuneiform writing, and shows how it came into being and developed. Though so different in appearance now, the cuneiform characters were originally of a pictorial origin, and they appear to have been invented by the Sumerians, a race of people who are generally believed to have come from a Turanian stock. Their earliest forms we now know did not consist of wedges, but of *lines*, and in the characters of *linear* Babylonian the natural objects which they were intended to represent can still be traced. In a table on p. 4 Mr. King gives us four distinct forms of fourteen characters, which date from B.C. 4500, B.C. 2500, B.C. 700, and B.C. 500 respectively; these illustrate clearly the manner in which linear picture forms become groups of wedges, and in a series of notes he shows by comparisons with Egyptian hieroglyphics that the old Sumerian characters, when they were first written down, must have been very similar to those of ancient Egyptian. The Assyrians appear to have been ignorant of this fact, and it is quite clear from their lists of archaic

characters that they could do little more than speculate about it. Mr. King decides, and rightly, that the cuneiform system of writing was produced by the material upon which the Sumerians and Babylonians wrote. On stone it was comparatively easy to cut linear characters, or even signs in which circles and semicircles occurred; but on clay a circle or a crescent could not be made quickly with the three or four-sided stylus, and the outline of a round, or oval, object had to be represented by a series of wedges. That clay became a popular material for writing upon is proved by the fact that its use extended from Elam in the east to Syria in the west, and from Lake Van in the north to the head of the Persian Gulf in the south; the cuneiform system of writing was in use continuously in Mesopotamia for about 4500 years.

Passing next to the decipherment, in an interesting chapter there is set before us the history of the discovery of the Persepolitan inscriptions by early travellers, such as Antonio de Gouvea and Garcia de Sylva y Figueroa, Pietro della Valle and others; the first useful copy of these was made in 1765 at Persepolis by the great Niebuhr. The first successful step towards decipherment was made by Grotefend, but it was not until 1837, when the late Sir Henry Rawlinson took the matter up, that any substantial results were obtained. Mr. King gives us copies of the inscriptions from which Sir Henry recovered the names of Darius, Hystaspes, and Xerxes, and clearly explains his method step by step, and two "cuts" give us an idea of the situation of these important inscriptions on the rock at Elwend and of the famous trilingual inscription at Behistun. The narrative of the manner in which Sir Henry overcame all difficulties is extremely interesting, and the world owes almost as much to his physical as to his mental energy.

Want of space prevents us from doing more than mention the Susian and Babylonian texts at Behistun, and we therefore pass on to note that the third chapter is devoted to a description of the system in which cuneiform characters are employed as syllables, ideographs, and determinatives. It is astonishing that the Assyrians or Babylonians did not reduce their cumbrous syllabary to an alphabet, as did the Egyptians and the Persians. Following this description we have a good selection from the Assyrian syllabary, printed in the cuneiform character, with syllabic and ideographic values, &c. The latter part of Mr. King's work contains a series of interesting extracts from cuneiform texts, with transliteration and translation arranged with them either interlinearly or on the opposite page, and the last few pages of the volume are devoted to a small glossary. For a book of the size no one could expect long dissertations on abstruse points of grammar or history, it being clearly understood that for matters of this kind the advanced student must consult the larger works on Assyriology.

The little volume before us is admirably suited for the purpose for which it is intended, viz., to enable the beginner to lay hold upon the first principles of the Assyrian language, and the frequent use of cuneiform type throughout its pages will help him to become familiar with the difficult character in which the sages of Mesopotamia in all ages seem to have written down their wisdom. The cuneiform type is clear and very legible, and is, if we mistake not, copied from the fount which was specially cast for Rawlinson's "Cuneiform Inscriptions," but was at the last moment abandoned in favour of lithographic copies of texts made first by Mr. Bowler and after his death by Mr. Jankowski.

ELEMENTARY HISTOLOGY AT CAMBRIDGE.

Practical Histology. By J. N. Langley, M.A., Sc.D., F.R.S. Pp. viii + 340. (London: Macmillan and Co., Ltd., 1901.) Price 6*s*.

THIS book is an embodiment of directions for practical work in animal histology, which the author, as the result of twenty years' experience, has been led to regard as best suited to the requirements of the elementary student, with the greater part of those of the histological section of the last edition of the "Practical Physiology and Histology," by Sir M. Foster and himself—one of the best established of the famous red-cover series of didactic manuals for students, which have done so much for the practical side of modern scientific instruction. The body of the book (286 pp.) is divided into thirty-six lessons, of which the first eight are devoted to methods and the use of the microscope and microtome. Those numbering nine to thirty-five are set aside for the tissues and organs, and the thirty-sixth deals very slenderly with the main facts of cell-division. In each of these "lessons" there are first given such accounts of the organs and tissues as are necessary for manipulative purposes, and descriptions of methods of treatment likely to yield constant results in the student's hands. There follows for each lesson, under the heading "Demonstrations," a list of objects to be correlatively studied or examined; and finally (in small type) a series of "Notes," having reference to cognate and alternative objects of interest and to methods supplementary to those described in the body of the lesson, with especial reference to such as require particular skill and attention or are variable and uncertain in their action. *Apropos* of this arrangement (which is but an extension of that adopted for the volumes which preceded the present one) and the "Notes," the author points out, with commendable care, that he has been careful to avoid making manipulation too much of an end in itself; and he thereby introduces a welcome check to the tendency on the part of pure histology to lapse into a mere laborious idleness.

The book is up to date and evenly balanced, and is sure of success equal to that of its predecessors. In his acknowledgments to those who have helped him the author naïvely alludes to the "unending suggestions" for "modifications in procedure," and we have these in evidence in many of the pages of the book.

It may now more than ever be said of animal histology that the history of its progress is that of method, since, on this basis, the far-reaching generalisations of Ramon y Cajal, which but seven years ago threatened to revolutionise our conceptions of the structure and mode of action of the nervous and sensory epitheloid apparatus, are by Apathy and others being challenged. Cajal's methods receive recognition in the present work. While we could hardly expect this for Apathy's until more fully confirmed, we could desire a fuller recognition of the discovery by Dogiel of the double innervation of

Meissner's corpuscle, and of the rapidly accumulated evidence of the same condition in that of the Pacinian, Herbstian, and even the Grandryian type. This discovery, which we owe to Dogiel and his pupils, with Timofeew and Sala, imparts a new character to the tactile body in all its forms; and it marks one of the most welcome and important advances in recent histological work, demanding the attention of even the elementary student. If only it had been made in Cambridge!

OUR BOOK SHELF.

A Catalogue of the Lepidoptera of Ireland. By W. F. De Vismes Kane. With a coloured plate. Pp. xviii + 166. (London: West, Newman and Co., 1901.) Price 10*s*.

THE earliest catalogues of Irish Lepidoptera were published by the Rev. Joseph Greene and the Rev. A. R. Hogan in 1854 and 1855 in the first two volumes of the *Natural History Review*, but were merely tentative, not only being very incomplete, but including many species on the evidence of collections without history, or else taken in localities where they were almost certainly introduced. These authors enumerated 636 species as Irish. The late Edwin Birchall's list, published in the *Entomologists' Monthly Magazine* from 1866 to 1868, was a much more valuable work. Mr. Birchall enumerated 974 species, though several included in the former lists were very properly omitted. The list now before us, which was originally published in the *Entomologist* from 1893 to 1900, is carefully compiled, chiefly from original sources, and brings down the subject to the present time; but the species are not numbered, and no comparison is made, as should have been done, with the number given in Mr. Birchall's catalogue.

Mr. De Vismes Kane's book will be very useful to entomologists visiting Ireland, or to those anxious to study the character of the Irish fauna from a Lepidopterous point of view. This is discussed by the author in his introduction, in which he refers not only to the comparative poverty of the fauna, both as regards number of species and of individuals, even in comparison with England, but states that the climate has been so unfavourable to insects of late years that they have become still scarcer than before, while some species, formerly common in certain localities, have apparently disappeared entirely. On p. xviii. the author alludes to his having assisted Colonel Cooper in 1885, 1886 and 1887 in the attempt to introduce various Continental species into Sligo, experiments which, happily, failed. He adds: "The attempted acclimatisation of such exotics as the above I consider wholly unobjectionable, since if it were successful, none of the species could have been mistaken for natives." Among these "unobjectionable species" was *Porthetria* (or *Liparis*) *dispar*, the gipsy moth, the introduction of which might have been one of the most grievous calamities that has befallen Ireland for many years; and this gives us the opportunity of suggesting that the Government should absolutely prohibit the rearing of any species in the open which are known to be destructive abroad, notwithstanding their being rare or unknown in the British Islands; while a specially heavy penalty should be attached to the introduction of living specimens in any stage or for any purpose of such species as *Liparis dispar*, as in the case of the not more destructive Colorado potato beetle. What would Colonel Cooper have thought if in a few years he had found that the whole of his forests were being stripped of their leaves by the larvæ of *Liparis dispar*, as might easily have been the case had the climate and conditions proved favourable to the insect?

An Atlas of the Medulla and Midbrain. By Florence R. Sabin. Pp. 123; 7 coloured plates, one black plate and 52 figures. (Baltimore, Md., U.S.A.: The Friedenwald Company, 1901.) Price 1·75 dollars.

THIS book consists of a detailed account of a model of the medulla oblongata, pons Varolii and mesencephalon, which was made in the anatomical laboratory of the Johns Hopkins University by a reconstruction in wax of every alternate slice of a series of horizontal sections of the brain-stem of a new-born babe. The sections had been stained by the method of Weigert, so as to differentiate clearly the various nerve tracts, which are so distinct, the one from another, at the time of birth.

In the reconstruction only the important nerve tracts and the compact masses of grey matter have been represented, so that a glance at the model reveals the exact shape and relations of the peculiarly-contorted grey-masses and intertwining fibre-tracts, and enables the student to form an accurate mental picture of the most complicated and difficult region of the brain, such as no other method of study can convey.

Miss Sabin has carried out the arduous and laborious task of building the reconstruction in a manner so careful and patently successful that for the first time an accurate and trustworthy model is provided of a region which so many people have hitherto attempted to represent graphically by less tedious and correspondingly more inaccurate means.

The series of drawings representing the wax reconstruction has been so happily executed by Mr. Max Brödel that the model itself is hardly necessary.

Miss Sabin's description is full and complete and is illustrated by a large number of drawings both of the horizontal sections, from which the model was built up, as well as a "control series" of transverse sections of another brain-stem of the same age.

The view obtained of familiar structures is so novel, and one's attention so riveted in the mental accommodation, that the reader hardly looks for new observations. Nevertheless, the author has not only critically summarised the current literature of the structure of the medulla, pons and midbrain, but has also added to our knowledge of these regions.

The bibliography, which is intended for students, attains the happy mean of being sufficient without being bewildering.

In a work which is so happily conceived and so admirably executed there is little call for criticism. In perusing the work we noticed only one misprint. One of the figures (Fig. 50) has been misplaced; and it would be of considerable advantage to the student if Plate viii. were inverted so that the parts might be placed as they are in the body (and in Plate iii.).

This book and the model which it describes must convince anyone, who has carefully studied the structure of the brain-stem by means of the examination of sections, of the inadequacy of the conception of this complex region which he can acquire by such means; and it will be an invaluable aid for conveying to students an accurate understanding of this important part of the brain, which could not otherwise be acquired even by months of careful study. G. E. S.

Les Variations de Longeur des Glaciers. By Charles Rabot. Pp. 250. (Geneva: Georg and Co., 1900.)

THE study of the variations in the lengths of glaciers is one that has formed the object of investigation of many workers, and as the subject, besides being of considerable interest, is one in which exact information is very difficult to secure, various opinions may be formed as to the lengths of the periods of variations deduced.

What is therefore wanted to render deductions more exact is a great number of observations, spread over a considerable interval of time, and the more the observa-

tions can be made on a uniform plan, the more accurate will be the results obtained.

In February 1897, M. Rabot published the first part of the present work on the variations of the lengths of glaciers in the temperate and Arctic regions, and since that time the subject has been taken up by several other enthusiastic workers, so that now important information has accumulated. Thus Prof. Erich von Drygalski has made a study of the glaciers in Greenland, Prof. E. Richter has worked at the glaciers in Norway, while Mr. Israel Russell has confined his attention to North America.

In the book before us M. Rabot brings together all the data concerning the measures and appearances of the glaciers in the Arctic and temperate regions, giving references in each case to the original source of information. In the last chapter he brings together the conclusions to which he has arrived, but the reader must be referred to the book itself for a full account of them. The main results may, however, be here briefly expressed, and they are as follows :—

Prior to the eighteenth century, glaciers were much less extensive than they are to-day. During the eighteenth century and up to the first years of the nineteenth, an enormous increase, surpassing the amplitude of a single variation, occurred. Glaciers invaded territories which had never been previously occupied. This increase was general and affected all those in the northern hemisphere. During the nineteenth century the variation was indecisive. In some regions a considerable increase followed by a slight diminution in glaciation was noted, while in others the glaciers, after having remained at a maximum up till nearly the end of the century, diminished slightly. In no part was there such a considerable regression observed as that recorded in the Alps during the last fifty years.

With regard to the question of the oscillations of the lengths of glaciers in consequence of the variations of climate, which Prof. Richter has indicated does occur in the case of the Alpine glaciers, M. Rabot suggests that our knowledge is at present too incomplete to settle such a point with certainty.

Before bringing these remarks to a conclusion it may be added that this important work adds much to the advancement of our knowledge of the secular variations of the lengths of glaciers, and M. Rabot is to be congratulated on the important part he has so successfully played in its production.

Experimental Hygiene. By A. T. Simmons, B.Sc., and E. Stenhouse, B.Sc. Pp. viii+322. (London : Macmillan and Co., Ltd., 1901.) Price 2*s.* 6*d.*

IN their preface the authors state that the value of an introduction to the scientific method in the school training of both sexes is now recognised. That is so ; but the scope and treatment of this scientific matter is the subject of a considerable amount of controversy at the present time among different authorities. Certainly no more suitable means exist of illustrating physical and chemical laws than by demonstrating their operation in the ordinary every-day occurrences with which the student is familiar.

It is no exaggeration to say that without some scientific knowledge the intelligent appreciation of the principles of hygiene and domestic economy is impossible. The writers of the work are therefore to be congratulated on having undertaken it with so excellent a motive, and one turns with considerable interest to the subject-matter to see how far they may be judged to have attained their object.

By the authors' scheme each subject is dealt with by first describing a few simple experiments and their results, then the physical and chemical principles responsible for those results are explained, and lastly it is pointed out how these principles are applied, or how they serve to explain certain every-day occurrences. At the end of each chapter there is a brief summary of the facts therein dealt with, and a series of exercises are then set out for the student. The book is well balanced throughout in its treatment of a large variety of scientific facts, and the matter is sound and well selected. The sole instance which we have noted in which exception may be taken to the teaching has reference to a simple means of filtering water. On pp. 148–149 the student is advised to clean a flower-pot and plug the hole at the bottom with a piece of sponge, then to place sand, with pebbles or charcoal, into the pot. Such a filter would not be efficient, and the householder would be safer if in his wisdom he preferred to drink the unfiltered water rather than make use of it.

The book concludes with an excellent chapter upon micro-organisms, where, in only nine pages, an account is given of those interesting growths which well meets the requirements of such a work. It is, in short, just sufficient to give the student an intelligent appreciation of what germs are. The book can be confidently recommended. It is of a handy size and well printed and bound.

Dictionary of Philosophy and Psychology. Edited by J. M. Baldwin. Vol. i. Pp. xxiv+644 (A—Laws of Thought). (New York : The Macmillan Co. London : Macmillan and Co., Ltd., 1901.) Price 21*s.* net.

THIS long-promised work will be of the highest value to every worker in fields which are in any way touched by psychological or philosophical thought. The contributors are almost all men of the highest eminence in their subjects, and the general editor has long been known as one of the ablest of the younger American psychologists. Some of the longer articles (*e.g.* "Brain") are really scientific treatises in miniature ; where brevity is possible the articles are most laudably brief. A particularly valuable feature of the work is the series of monographs on philosophical terminology (arts. "Greek Terminology," "Hegel's Terminology," "Kant's Terminology"), by Prof. Royce, of Harvard. The outward appearance and the typography of the book reflect the greatest credit on the publishers and the Oxford University Press.

The end of the alphabet is to be reached in vol. ii., and vol. iii. will consist of a series of full bibliographies of the various departments of philosophical and psychological literature. A. E. T.

Die Vogelwelt des Amazonenstromes ; Enstanden als Atlas zu dem Werke "Aves do Brazil." Von Dr. Emil A. Goeldi (1894–1900). Part i. (Zurich : Polygraphischen Institut, 1900.)

WE have received from the Polygraphischen Institut of Zurich a copy of the first part of this atlas, which is merely a replica in German of the one noticed in our issue of August 22, 1901, under its Portuguese title of "Album de Aves Amazonicas." In fact, it is only the cover that has been altered, the descriptions of the plates themselves remaining in the original Portuguese. We have nothing to add to the remarks made in the notice referred to, except that the plates are excellent examples of three-colour printing.

The Bettesworth Book. Talks with a Surrey Peasant. By George Bourne. Pp. vi + 325. (London : Lamley and Co., 1901.) Price 5*s.* net.

FROM a scientific point of view there is little of interest in this book, but as a realistic record of the thoughts and experiences of a Surrey labourer, reproducing more or less the dialect of the county, the conversations are certainly worth preserving. There is no attempt at fine

language or refined rhapsodies on rural life and scenes, but in natural vigorous words Bettesworth—that was the name of the labourer—gives his opinion upon sundry persons, places and things he has known. The ethnographer will here and there find descriptions of country customs and remedies which will interest him.

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.*]

Relative Velocity in Streams.

IN your review of the report of M. Vallot from his observatory on Mont Blanc (p. 31) you speak of his finding that a stream ceases to increase in speed in a channel of greater incline than 3 in 100 as something unexpected.

For more than twenty years I have contended, in repeated publications, that friction against the bed increasing progressively from the middle to the margin divides every stream longitudinally into two halves, which roll spirally toward each other. This spiral being determined by the friction, its helix rises with the speed, or the increased friction depending on the speed, which in turn depends on the slope of the channel. It follows that beyond a certain speed the stream loses all the momentum gained by its fall in beating with the two outward-moving undercurrents against the channel walls. In this way the stream attains its kinetic equilibrium. If glaciers are plastic or viscous bodies, they, too, must obey the same laws.

Louisville, Kentucky, U.S.A. D. T. SMITH.

Change of Pitch of Certain Sounds with Distance.

IN NATURE of December 12 (p. 129), Mr. F. M. West describes an observation made while walking up and down the platform of a railway station. The pitch of the sound caused by the steam escaping from an engine rose as he retreated from it and fell as he drew near to it.

As I gave the explanation of the same phenomenon in *Les Archives Néerlandaises* (Arch. Néerl. Livre jubilaire, November 1901), I may be permitted to give a summary in these pages.

The pitch will not only rise by retreating from the engine, but also by bringing the ear nearer to the ground. The pitch is due to reflection of the sound from the platform itself, for when a large board is laid down on the ground between the engine and the observer, the pitch will be heard to rise when the board is raised.

It is clear, therefore, that the pitch can be caused by interference of the direct and the reflected sound-waves, a phenomenon wholly similar to Lloyd's experiment with light-waves. As in Lloyd's experiment the elementary colours of the white light are separated in space, so here the different pitches of sound will predominate in different points of space, and a sort of sound-spectrum will be formed.

A mathematical examination enables us to analyse the irregular vibration of a noise during a short time, according to Fourier, into a series of harmonic vibrations. Moreover, it can be proved by calculation that the interference of the direct and the reflected sound-waves must cause at any spot a series of (impure) pitches to be heard. The wave-lengths of these pitches must be 1/1, 1/2, 1/3 . . . of the difference of distance travelled over by both sounds.

An experimental examination, made at the platform of a railway station, has shown me that the pitch of the noise of an engine fully agrees with the theory, so far as the impurity of the pitch permitted an exact experiment to be made.

When the noise of a waterfall or rustling trees is perpendicularly reflected by a wall, Baumgarten has observed the change of pitch in the vicinity of this wall (Müller-Pouillet, "Lehrbuch der Physik," i. p. 732). The above-mentioned result is also applicable in this case. In the neighbourhood of a waterfall I obtained experimental results perfectly agreeing with theory. D. VAN GULIK.

Apeldoorn, December 15.

CHEMICAL INSTRUCTION AND CHEMICAL INDUSTRIES IN GERMANY.

JUST now, when men of science and educationists are continually directing attention to the superiority of German educational and industrial methods, especially in the domain of chemistry, a report published among the "Miscellaneous Series" of the Foreign Office is most apposite, and should be studied by all who are truly interested in the educational and commercial welfare of the nation.

The object of the report, which is compiled by Dr. Frederick Rose, His Majesty's Consul at Stuttgart, is "to show to what extent the German chemical industries have benefited by the sums expended by the German States on chemical instruction." A perusal of the contents of this highly interesting and instructive report shows us that the German technical high schools or polytechnics differ *in toto* from those of the United Kingdom. They are, in fact, more like our University colleges, *e.g.* Owens College and Mason College (new University of Birmingham). The older Universities in Germany began to study chemical technology about the middle of the seventeenth century. They thus laid the foundation-stone of the present-day industrial chemistry for which the country has become famous. As trade and chemical industries gradually advanced, the Universities were found inadequate to train the greatly increased number of chemists who were required. The polytechnics (now called technical high schools) were consequently founded. These are, without exception, products of the nineteenth century. One must not, however, lose sight of the fact that it is only within the last two generations that the technical high schools have assumed such prominence. They had first to learn what was required of them if they were to exert a really beneficial effect upon the welfare of the country. On p. 8 of the report the following words appear, which we trust some of our technical educationists will take to heart :—

"The study of architecture, engineering and chemistry at the technical high schools left, at the beginning, much to be desired, as the erroneous opinion prevailed that it was not necessary for the students to devote themselves to the study of scientific works, but rather to acquire a certain practical aptitude in superficial manipulation. . . . Later on, however, it was clearly perceived that the scientific foundation laid during the scientific courses at the technical high schools formed the soundest basis for the practical experience to be gained during professional life."

In the British polytechnics the teaching staff have no social status, and the scale of remuneration depends entirely upon the governing body, who have usually great difficulty in making both ends meet. But in the Prussian technical high schools, which are under the direct control of the State, the members of the professional staff possess the rank of full State officials, and the salaries are regulated according to certain fixed limits. Indeed, so deeply is the German Emperor convinced of the importance of technical education that he has caused the directors of the Prussian technical high schools to be admitted to the Prussian Upper House, while a short time ago at the centenary of the Berlin Technical High School he conferred upon the Prussian technical high schools the right to confer a new degree of Doctor of Engineering, thus practically raising the technical schools to the level of the Universities.

Before the students are allowed to pass into the technical high schools they must show that they have obtained a preliminary education of a very high order. Whilst it is no unusual thing in our polytechnics to find students who have absolutely no knowledge of the merest elements of arithmetic and who are quite unable

to enter the results of their experimental work in an intelligible manner, such students could not enter the German technical high schools.

Students of chemistry who enter the technical high schools do not devote the whole of their time to chemistry; they take out a full technological course, including such subjects as trigonometry, higher mathematics, physics, botany, electrotechnics, technical drawing, machine drawing, &c. The above subjects have been taken at random from the syllabus of the Darmstadt Technical High School for 1895. Perhaps, however, the thoroughness of the courses through which the student must pass before obtaining his technological diploma is best shown by a study of the syllabus of the Stuttgart Technical High School.

Subject	Number of hours per week					
	1st year		2nd year		3rd year	
	Summer term	Winter term	Summer term	Winter term	Summer term	Winter term
Mineralogy and geology ...	4	5	—	5	—	—
Zoology	3	3	—	—	—	—
Botany	—	—	3	6	—	—
Physics	4	4	—	—	—	—
Experimental chemistry ...	4	4	—	—	—	—
Theoretical chemistry	—	4	—	—	—	—
Analytical chemistry	2	2	—	—	—	—
Organic chemistry	—	—	5	2	—	—
Technical chemistry	—	—	4	2	—	—
Dye industries	—	—	—	—	3	—
Building construction	5	—	—	—	—	—
Elements of machinery	—	—	5	6	—	—
Electro-chemistry	—	—	—	—	—	1
Political economy	—	—	—	—	3	—
Elementary jurisprudence ...	—	—	—	—	3	3
Microscopic laboratory ...	—	—	—	2	—	—
Chemical laboratories	12	12	12	12	24	24
Total	34	34	29	35	33	28

Any extra time at the students' disposal is devoted to practical chemistry, bacteriology, or the chemistry of foods, &c.

The pioneering labours of the German Universities are known to everyone. For pure chemical research they have obtained for themselves a position which places them almost above criticism, and which has made them the envy of the world, insomuch that students flock to them from all countries. In 1897 there were 13,000 students at the Prussian Universities; of these 9 per cent. were foreigners. Each of these students costs the State 31*l.* annually, or about 36,000*l.* In the Prussian high schools during the same year there were 4246 students, of whom 13 per cent. were foreigners, costing the State 14*l.* per head, or nearly 8000*l.* That is to say, in 1897 the Prussian State expended 43,000*l.* on the education of foreigners, many of whom would in all probability enter into trade competition with themselves. Taking the whole of Germany into account it is calculated that no less than 60,000*l.*, or the interest on 2,000,000*l.*, was expended in educating foreigners.

In one respect the German Universities and polytechnics possess an enormous advantage over those of this country—*they are not hampered by want of funds.* The German Government realises the importance of education, hence the Universities and technical high schools are built upon the most modern principles and fitted up in a style which is little short of perfection. It must not, however, be denied that here we also build and fit up polytechnics in a manner which leaves little to be desired, so far as the external structure and paint and varnish are concerned. But it so often happens that all the funds have been swallowed up by bricks and mortar, hence there is no money forthcoming for adequate equipment and maintenance,[1] much less for research. The result is, the teaching staff is miserably inadequate and consequently overworked.

The following table, the numbers in which are taken from the reports from University colleges, issued by the Education Department, gives the income and the Government grant for five of our University colleges for the year ending July 31, 1899:—

	Income.	Government Grant.
	£	£
King's College, London ...	42,369	... 2200
University College, London	35,456	... 3000
Owens College	47,494	... 3500
University College, Liverpool	23,792	... 3000
Mason College, Birmingham	17,864[2]	... 2700[2]

Contrast this with the German Universities and technical high schools; for our Universities and University colleges, as well as our polytechnics, are but too often without sufficient income.

In 1899 the total income of the University of Berlin was 143,555*l.*; of this large sum no less than 83 per cent. was contributed by the State, while 80 per cent. of the income of the University of Bonn (63,037*l.*) was obtained from the Government. Turning to the technical high schools, that of Berlin, with a total income of 69,077*l.*, received 33,675*l.*; Hanover, total income 25,240*l.*, obtained 15,094*l.*; while Aachen, having an income of 22,998*l.*, received 16,581*l.* from the Government. The teaching staff of the chemistry department—I have not the numbers for the other departments—is also on an equally lavish scale, as the appended table shows:—

	Teaching Staff.	Students.
Heidelberg University ...	10	... 315
Strasburg University ...	7	... 48
Berlin Polytechnic	44	... 278
Stuttgart Polytechnic ...	10	... 88
Karlsruhe Polytechnic ...	15	... 139

It has already been mentioned that the technical high schools are taking a more and more leading place; this is shown by the fact that during the last seventeen years the students at the technical high schools have increased 206 per cent., whereas at the Universities the increase is only 12 per cent. In some chemical works preference is given to students who have studied at the technical high schools, one reason being that technical high schools devote much more attention to the teaching of technology. It is estimated that there are in Germany about 4500 trained chemists who have had the full courses at the Universities or technical high schools. But notwithstanding this vast array of expert technical chemists and the preeminent place which German chemical industries have obtained, in chemical industrial circles in Germany there is a widespread feeling that there must be no resting on their oars, but that increased facilities for technical education must be obtained, and it is felt that, unless the Universities devote more attention to technology, the diminution in the number of students will in the course of ten or fifteen years react most unfavourably upon the German chemical industries. How much more so is this the case in our own country, where chemical technology is rarely taught? At our Universities and polytechnics we appoint *one* professor, who has to teach all the branches of chemistry. In Germany there is a professor set apart to teach technology, a

[1] The Technical Education Board of London do their best to remedy defects in equipment, but their funds are not unlimited, and it is not their province to pay for the general upkeep of the institutions.

[2] This does not include the day training college, which has an income of 5400*l.* and 3679*l.* in the form of grants from the Education Department.

special lecturer for physical chemistry, and very often a professor for organic and another for inorganic chemistry, beside numerous lecturers on different branches of the subject.

The German nation, which has placed its primary and technical education on a sound basis, has been richly rewarded. In 1897 the total production of the German chemical works was 47,391,132*l*. Within the last twenty years many new and flourishing industries have been started, the foundation of which has been entirely due to the results of chemical research. Again, one has only to glance at the appended list, which shows the dividends of some of the larger chemical works, all of which employ a large staff of fully trained chemists, to recognise that science and successful commerce go hand-in-hand :—

Name of works	Dividends 1893 Per cent.	1896 Per cent.	1899 Per cent.
Höchst Colour Works	28	28	26
Baden Aniline and Soda Works ...	27	26	24
Elberfeld Colour Works	18	18	18
Schering and Co., Berlin	19	11	12
Nobel and Co., Hamburg	21½	13	18
Munich Paper Works	15	16	18
Rositz Sugar Works...	3	12	13

In this country the Government relies too much upon private initiative and individual generosity. Because nearly all the pioneering labour and many of the most brilliant scientific results of the past century have, so far as this country is concerned, been conducted by private individuals who were fired with the restless and resistless energy of genius, the Government and the manufacturers wrap themselves in an impenetrable armour of self-complacency and blind optimism. Our forefathers, they say, had practically no scientific education, and see how they excelled in invention and obtained the control of the commercial world. Let them, however, remember that in those days the Germans had also practically no scientific education, neither was their empire consolidated as it is at the present moment. So long as the Government refuses to recognise the needs of science, and manufacturers, with fatuous obstinacy, refusing to learn from the experience of other nations, look upon chemists as expensive luxuries, so long will chemical trade remain in the hand of our rivals.

F. MOLLWO PERKIN.

THE GEOLOGICAL SURVEY OF THE UNITED STATES.

IN NATURE for December 27, 1900, we noticed the first and sixth parts of the Twentieth Annual Report of the United States Geological Survey. We have now received the remaining volumes. Part ii., comprising "General Geology and Palæontology," consists of 953 pages with 193 plates. It includes a brief article on the geology of the Philippine Islands, by Mr. G. F. Becker ; but as we have since received the full report (noticed further on), we may pass on to the next paper by Mr. J. Nelson Dale, a study of Bird Mountain, Vermont. This mountain, the summit of which is 2200 feet high, lies in the Taconic Range, and consists of about 500 feet of Ordovician grit and conglomerate interbedded with muscovite-schist, and underlain by similar schist with beds of quartzite. The author discusses the origin of the mountain, the features of which have been largely sculptured by glacial action. The Devonian fossils from south-western Colorado, constituting the fauna of the Ouray Limestone, are described by Mr. George H. Girty. Although by some authorities regarded as Carboniferous, Mr. Girty considers that the fauna indicates late Middle or early Upper Devonian. Varieties of *Spirifer disjunctus* occur, together with numerous other fossils.

A preliminary paper on the geology of the Cascade Mountains in Northern Washington is contributed by Mr. Israel C. Russell. The rocks comprise granite, various schists, greenstone and serpentine of unknown age, and also a great extent of slightly altered and unaltered sedimentary strata, mainly Cretaceous and Tertiary, with some possibly of Jura-Trias age. The granites and allied rocks are usually jointed in a conspicuous manner. The influences of these joints on the rugged spires and cathedral-like forms resulting from weathering are among the most characteristic details in the magnificent scenery of the Cascade Mountains. The structure of the range is highly complex. This is briefly described, and fuller particulars are given of the striking effects of glaciation.

Mr. Lester F. Ward is the author of an elaborate essay on the older Mesozoic floras of the United States, Triassic and Jurassic ; and Mr. David White deals with the stratigraphic succession of the fossil floras of the Pottsville formation in the southern anthracite coal-field of Pennsylvania. The plants of this Carboniferous formation exhibit a rapid development, and a series of changes or modifications, which are considered of high stratigraphic value.

Part iii. deals with the "Precious-metal Mining Districts." The Bohemia mining region of western Oregon is described by Mr. J. S. Diller. It is situated at an altitude of between 4000 and 6000 feet above the sea, along the crest of the Calapooya Mountain, and upon both slopes. The mountain is composed of lavas like those of the Cascade Range. Generally the sheets of lava are very irregular. The lava filling the throat of a once active volcano has in the case of the Cougar Rock made a prominent peak, while in Bear Bones Rock it presents a conspicuous columnar structure. The streams have cut deep, narrow valleys, approaching canyons in character. These expose rocks to a depth of more than 2000 feet—comprising lavas (chiefly andesites), vein matter and stratified fragmental volcanic material. It is probable that volcanoes were active in Eocene times, and continued so during the Miocene period. The veins lie along narrow, irregular joint-planes in which there has been much crushing of rock material. The principal gangue is quartz, containing at a depth much pyrites and other sulphides in which gold occurs ; while near the surface the gold is native, finely filamentous and distributed through iron-stained quartz. The output in this region has been chiefly from one mine during the last few years. Mr. F. H. Knowlton contributes an account of the Miocene plants of the Cascade Range.

The gold and silver veins of Silver City, De Lamar, and other mining districts in western-central Idaho are reported on by Mr. Waldemar Lindgren. The area includes four types of scenery : (1) the Snake River valley, extensive arid plains underlain by Neocene lake-beds with intercalated flows of basalt, which are cut into to a depth of from 400 to 1000 feet ; (2) the Owyhee Range, a steep granite ridge covered by broad areas of Neocene lavas ; (3) a great central granite region north of the Snake River, with bordering sedimentary rocks, probably Palæozoic, showing extensive contact metamorphism : the whole described as a veritable labyrinth of ridges and peaks separated by sharply-cut canyons, the higher ridges attaining elevations of 12,000 feet, and evidently an old plateau with an intricate and deeply-cut drainage system ; and (4) a more recent plateau of the Columbia lava flows, of Miocene age.

The mineral deposits of the great granite area are fissure veins, containing gold and silver in a quartzose gangue. The adjoining sedimentary areas carry either veins or contact deposits of irregular shape, generally containing silver, lead, zinc and copper. The Tertiary volcanic rocks contain in places gold and silver veins

of peculiar character. Considerable amounts of placer deposits are found in the gravels associated with the Neocene lake-beds. It is considered that some of the mineral veins may be of Cretaceous or Eocene age, some may be older, and others are post-Miocene.

Mr. W. H. Weed describes the geology of the Little Belt Mountains, Montana, an elevated and eroded plateau region. Gneisses and schists form a central core, upon which rest a great variety of sedimentary rocks, penetrated by igneous rocks, which appear as dykes, sills and laccolites. Silver-lead ores, gold, iron ores and sapphire mines are described. The petrography of the igneous rocks is dealt with by Mr. L. V. Pirsson, who describes syenite, monzonite, shonkinite (a basic granitoid rock) and many other rocks. The rock in which the sapphires occur is allied to the minettes and shonkinite, and it appears to have derived its alumina from clay-shales through which it was intruded; the molten rock on its way incorporating shale-fragments in its mass. The many subjects dealt with in this elaborate memoir are fully illustrated with views, diagrams and plates of microscopic sections of rocks.

Part iv., on "Hydrography," deals with stream measurements and reservoir sites, and there is a special article on Nicaragua. The volume is well illustrated with views and diagrams. Part v. is on "Forest Reserves," and has excellent maps, views of scenery and woodland, and notes on soils and timber-trees. Part vii., "Explorations in Alaska," is a volume of more than 500 pages, profusely illustrated, and dealing with the topography, geology, agriculture, game, and inhabitants.

Mr. George H. Eldridge gives an account of a reconnaissance in the Sushitna Basin and adjacent territory. Here the geological formations include granite, schists and slates, and a series of conglomerates and sandstones of undetermined age; also sandstones and shales with coal-seams belonging to the Eocene; and sundry Drift deposits. Traces of gold occur in the pyritiferous quartz of the slate series, but elsewhere in placer deposits. The coal is a low-grade lignite.

Mr. J. E. Spurr deals with south-western Alaska, and his report is accompanied by a coloured geological map showing gneiss and schists, Silurian, Carboniferous-Devonian, Jurassic, Cretaceous, Eocene and later deposits, as well as Tertiary intrusive and volcanic rocks. He describes as fully as possible the sedimentary and eruptive rocks, and with regard to the latter employs the name Alaskite group for certain quartz-alkali-felspar rocks, and Belugite group for rocks transitional between the diabasic and dioritic families.

Mr. W. C. Mendenhall describes the country from Resurrection Bay to the Tanana River; Mr. F. C. Schrader deals with a part of Prince William Sound and the Copper River district; and Mr. A. H. Brooks with the White and Tanana River basins.

One general conclusion is that Alaska is eminently not the place for the haphazard or untrained prospector; and that in the long run only those who have the intelligence, training, and patience to study the conditions of the occurrence of gold can hope to succeed.

We have received the first and sixth parts of the Twenty-first Annual Report. In Part i. the director, Mr. Charles D. Walcott, refers to the reorganisation of the geological branch which came into effect in July 1900. The need was felt of closer and permanent supervision in scientific lines, and the Geological Survey was subdivided and each division placed in charge of a specialist as follows:—Areal Geology (stratigraphy, structure and pre-Pleistocene physiography), Bailey Willis; Pleistocene Geology, T. C. Chamberlin; Palæontology, T. W. Stanton; pre-Cambrian and Metamorphic Geology, C. R. Van Hise; Mining and Mineral Resources (distribution and production of economic minerals), D. T. Day; Economic Geology (metalliferous ores), S. F. Emmons (non-metalliferous deposits, &c.), C. W. Hayes; Physical and Chemical Research, G. F. Becher. Accompanying this volume is an obituary notice of Prof. O. C. Marsh, prepared by Mr. Arnold Hague.

Part vi. consists of two volumes, dealing with mineral resources. The great demand for mineral products led to an increase in 1899 over 1898 of more than 10 per cent. in output and of more than 39 per cent. in value. Nearly every important "mineral" participated in this increase, notably pig iron, copper, coal, natural gas, petroleum, cement and stone. Lead showed a decline. The value of grindstones was large and that of oilstones and whetstones the largest on record. Pigments, again, were in great demand. Fuller's earth was produced in less quantity and more was imported; it is used partly for decolorising vegetable oils.

We have also received a reprint from the Twenty-first Annual Report, Part iii. (1901)—a Report on the Geology of the Philippine Islands, by Mr. George F. Becker, with notes on the Tertiary fossils, by Mr. K. Martin. In these islands schists and massive crystalline rocks occur, together with diorites, diabases, and gabbros. Of newer volcanic rocks there are basalt, andesite, dacite, and probably trachyte and rhyolite. A considerable number of volcanoes have ejected ash and lava recently, or since the occupation of the country by the Spaniards. Tertiary strata from Eocene upwards are well developed in the islands, but have been imperfectly studied. Of mineral resources there is a brown coal of Tertiary age, while gold-mining is an ancient industry. Even the tricks of the trade are not unknown to the natives, and they "nearly succeeded in inducing some American officers to take an interest in gravel salted with brass filings." The auriferous deposits include veins, placers, and river sands. The occurrence of copper, argentiferous lead-ore, and magnetic iron-ore is noticed.

In addition to the Reports already mentioned, we have received Nos. 163 to 176 of the *Bulletin* of the United States Geological Survey, all published in 1900. These deal with a variety of subjects, and not the least useful is that by Mr. F. B. Weeks (No. 172)—a bibliography of American geology for 1899, in which 799 articles are listed and indexed.

Of purely geological articles we have a reconnaissance in the Rio Grande coal-fields of Texas (No. 164), by Mr. T. V. Vaughan. Although the State is by far the largest in the Union, embracing a quarter of a million square miles of territory, it stands low in the scale of coal producers. The coals occur in strata of Upper Cretaceous and Eocene age, and they vary in thickness from a few inches up to 7 feet. Details are given of the strata and their fossils, and it is remarked that there are not yet sufficient data to trace accurately the boundary between the Cretaceous and Eocene. The Cretaceous coals of the Eagle Pass coal-field are regarded as of anthracitic type, and as by far the best fuel in America except the true anthracites of Pennsylvania. The Eocene coal is strictly speaking a lignite. Mr. E. C. E. Lord contributes a report on the igneous rocks of the San Carlos coal-field. These rocks indicate late Cretaceous or early Tertiary lava flows, and comprise rhyolite breccia, quartz-pantellerite, and basalt.

Contributions to the geology of Maine are made (in No. 165) by Mr. H. S. Williams and Mr. H. E. Gregory. Mr. Williams deals with the Silurian and Devonian faunas, and enters into a discussion of the characters and evolution of the Rhynchonellas. He remarks that there is no question as to the great importance of internal characters for purposes of determining the genetic relationship of organisms; but it is also a fact that the external characters do not cease to be of similar value. He points out that the taxonomic rank of characters rests

primarily upon their relative fixity, and not upon their supposed importance in the individual economy of the organism. Generic characters to be of taxonomic value must be distinguished from varietal and specific characters by their greater fixity, or what may be defined as their more exact reproduction or transmission in generation. He further remarks that the attempt closely to correlate specimens with some particular species diverts the attention from the evolutional laws which the evidence contains and illustrates. The study of a single group of species demonstrates the fact that the evolutional stage of the group is indicated with precision, independent of the names of the species, and independent of the fact that the specimens actually present in the Maine fauna agree precisely in scarcely a single case with those of any fauna in New York.

Mr. Gregory reports on the geology of the Aroostook volcanic area. North-eastern Maine is essentially a region of sedimentary rocks, with prominent exposures of igneous rocks in Castle Hill and Mapleton townships. This area appears to have been a distinct centre of volcanic activity. Rhyolites, trachytes and andesites are described. Elsewhere there are tracts of granite and other igneous rocks.

Of purely palæontological papers there is an account of the flora of the Montana formation (No. 163) by Mr. F. H. Knowlton. The formation is approximately of Laramie (late Cretaceous) age. There is also an elaborate synopsis of American fossil Bryozoa (No. 173) by Mr. J. M. Nickles and Mr. Ray S. Bassler.

Contributions to chemistry and mineralogy, with analyses of rocks, are given (in Nos. 167 and 168) by Mr. F. M. Clarke. Various crystalline and sedimentary rocks, soils, and meteorites, are dealt with. Mr. W. F. Hillebrand treats of some principles and methods of rock analysis (in No. 176). Of miscellaneous reports we have a gazetteer of Utah (No. 166), altitudes in Alaska (No. 169), and other topographical papers (Nos. 170, 171, 174 and 175).

Several Monographs published by the U.S. Geological Survey have also been received. Monograph No. 39 (1900) contains an account of the Eocene and Lower Oligocene Coral Faunas of the United States with descriptions of a few doubtfully Cretaceous species, by Mr. T. Wayland Vaughan. The author laments that the classification of corals is in a most unsatisfactory condition, but he has described his material with all possible care in the hope that ere long some one may be able to give a classification based on the actual phylogenetic grouping of the various genera. The larger the number of specimens the more difficult it is to define species: Mr. Vaughan has tried to be conservative, and when a form in one horizon grades into a form in the horizon next above, he has named them varieties of the same species, even when the variety possesses an individuality that makes it easily recognisable.

In Monograph No. 40 (1900) Mr. S. H. Scudder deals with certain Coleoptera from the Tertiary deposits at Florissant, Colorado, and gives a systematic list of the non-rhynchophorous Tertiary Coleoptera of North America.

NOTES.

H.R.H. THE PRINCE OF WALES has accepted the presidency of the Society of Arts, which was vacated by His Majesty the King on his accession.

DR. WILLIAM SOMERVILLE, late professor of agriculture at the University of Cambridge, has been appointed to be an assistant secretary to the Board of Agriculture in succession to Sir Jacob Wilson, who has retired.

DR. ARTHUR SMITH WOODWARD, F.R.S., has been appointed keeper of the Geological Department of the British Museum (Natural History), South Kensington, in succession to Dr. Henry Woodward, who retired on November 23 after a service of nearly forty-four years. Curiously enough, there is no family relationship between the present and past keepers.

MAJOR A. W. ALCOCK, F.R.S., Superintendent of the Indian Museum, Calcutta, informs us, that Mr. L. de Niceville died at Calcutta of fever contracted in the Darjeeling Terai, on December 3.

IT is announced by Dr. D. Morris that the fourth annual West Indian Agricultural Conference will be held at Barbados on January 4 and 6, 1902. The object of the conference, as laid down by the Secretary of State, is the reading of papers and discussion on the scientific and economic aspects of the sugar-cane and other industries. It is hoped that the subjects brought forward will be dealt with from a thoroughly practical point of view and with a full knowledge of the requirements and circumstances of each colony concerned.

THE death of Mr. James G. Shipman, F.G.S., deprives geological science of an ardent local worker, who did much to enlarge our knowledge of the rocks and fossils of the neighbourhood of Nottingham. He commenced life in comparatively humble circumstances; he was apprenticed to the printing trade, and was finally given a post on the sub-editorial staff of the Nottingham *Daily Express*. His interest in geology was aroused by lectures given more than thirty years ago by the late Edward Wilson. Thereafter he devoted himself to the subject with remarkable assiduity. His leisure hours were spent in studying all sections within reach of Nottingham, and he contributed a number of papers, chiefly on the Drift and Triassic deposits, to the Annual Report and *Transactions* of the Nottingham Naturalists' Society. Latterly he had paid much attention to the structure of the Nottingham and Derbyshire Coal-field, and had qualified himself to give expert advice on water-supply. He died on November 21, aged fifty-three.

A REUTER'S telegram states that Mr. William Bruce, the leader of the Scottish Antarctic expedition, has purchased the Norwegian steam whaler *Hecla* for his forthcoming expedition to South Polar regions. The *Antarctic*, with Prof. Nordenskjöld's South Polar expedition on board, left Buenos Ayres on Friday for the Falkland Islands. The *Discovery* left Lyttelton for Dunedin on Saturday afternoon, and has by now sailed for the Antarctic.

PROF. H. HERGESELL, president of the International Aëronautical Committee, informs us that arrangements are being made to continue the manned and unmanned balloon ascents during 1902, the dates proposed being the first Thursday in each month, except January, when the second Thursday is selected. Since November 7, 1900, 120 ascents have been made; the observations are now being discussed and will throw much light on the physics of the upper air. It is proposed to hold a meeting of the Committee next year in Berlin, when questions relating to new thermometers, observations of atmospheric electricity and magnetism will be discussed.

IN connection with the valuable series of forty years' observations taken at Camden Square (N.W. London), *Symons's Meteorological Magazine* for December contains the monthly results and extremes of solar temperatures for twenty-eight years commencing with 1870, made by both black and bright bulb radiation thermometers. The following are some of the values obtained by the black bulb *in vacuo*:—Highest monthly average, 123°·4, absolute maximum, 137°·7, both in July. Lowest monthly mean, 36°·9, absolute minimum, 24°·8, both in Decem-

ber. The absolute extremes by the bright bulb *in vacuo*—an instrument not in general use—were 105°·4 in July and 22°·5 in January.

THE fifth list of current papers collected and discussed by Mr. H. C. Russell, Government Astronomer of New South Wales, covers a period of thirteen months, from October, 1899, to November, 1900. No less than 448 papers were thrown overboard, mostly in the southern Indian Ocean, but only eighty-six of these were recovered; 106 papers were received during the period mentioned, but twenty of them had been more than thirteen months drifting. Three of the papers set afloat near the Cocos Islands landed on Africa and showed the high rates of 18·3, 20·6 and 25·4 miles a day, the latter being the record drift obtained by Mr. Russell. The following summary of the average drifts obtained in the Indian Ocean during the years 1893–1900 is very interesting:—from the equator to 10° S., 13·3 miles a day; from 10° to 30° S., 16·6 miles; from 33° to 43° S., 7·6 miles; from 43° to 50° S., 9·4 miles. Among the last series of papers, one thrown overboard off Cape Horn found its way to the west coast of Africa, in Ashantee, the drift in a straight line being 5350 miles in a N.N.W. direction, the rate per day being 10·1 miles. The track and daily position of the s.s. *Waikato* are shown on a chart and will be useful for other steamers which may have to drift in the same waters. This vessel broke her main shaft on June 5, 1899, in lat. 37° 30′ S., long. 21° 0′ E., and drifted about in the Indian Ocean until September 15, when her position was lat. 39° 29′ S., long. 64° 30′ E.

THE production of motive power from blast-furnace gases formed the subject of a paper by Mr. Bryan Donkin, read before the Institution of Civil Engineers on December 17. Only within the past few years has it been realised that power can be produced economically and effectively by utilising the gases from blast-furnaces to drive gas-engines. As the annual production of iron from blast-furnaces throughout the world is forty million tons, this new application of motive power is capable of immense development. The gases given off from these furnaces during the process of smelting iron are practically the same as weak producer-gas. Until within about half a century ago they were all wasted. A part was next utilised under boilers to generate steam to drive the blowing engines and part to heat the air-blast; but after supplying these requirements a considerable surplus was available. Successful efforts have been made, first to use this surplus in gas-engine cylinders, to obtain power, and next to discard steam-engines, boilers and chimneys entirely, and utilise all the gas in this way. A great impetus has been given to the construction of large motors by the discovery that blast-furnace gases can be used to drive them. They are now made in sizes up to 1000 h.p. and 1500 h.p., and still larger powers are in contemplation, while the difficulty of starting these large engines has been successfully overcome. Mr. Donkin gave some account of the very rapid progress made in this class of work on the continent. Many of the large firms in Germany and Belgium are now busily employed. The Gasmotoren-Fabrik Deutz has numerous orders for motors from 500 h.p. to 1000 h.p., while at Seraing, in Belgium, an aggregate of 39,000 h.p. has been bespoken. Messrs. Körting, of Hanover, have also supplied several engines, and the Deutsche Kraftgas-Gesellschaft propose to construct motors up to 1500 h.p. and 2000 h.p. It was remarked that England and Scotland seem rather slow to utilise these gases.

FROM an article in *Transport* it appears that oil has been very successfully used as fuel for steamers. An inspection of the *Clam* steamer, belonging to the Shell Transport Company, was recently made prior to her departure from the Thames for Philadelphia. It was shown from the vessel's log that for two years the steamer has been using oil instead of coal, and that it was found that eighteen tons of oil gave off more heat than twenty-eight tons of coal, and with improvements recently made it was expected that still better results would be obtained. The employment of liquid fuel also led to a considerable economy of labour, got rid of many of the difficulties attending the stokehold, and allowed a considerable addition to the space available for cargo. The *Clam* has relied solely upon obtaining a supply of oil from Borneo, and the company claim that from their wells in that country they can supply 100,000 tons of oil a day. The company are so satisfied with the results obtained that they intend to send to sea a fleet of eighteen steamers burning oil as fuel. In the United States oil is very largely superseding coal for locomotive engines, especially for street railways. In this country the Great Eastern Railway Company have many of their engines fitted for using oil as fuel, the advantage of which was found very great during the late high price of coal.

THE feature of the North Atlantic and Mediterranean pilot chart for January, issued by the Meteorological Office, is the introduction of the curves of equal magnetic variation for the whole of the sea space. They are for the year 1905, and are drawn for each 2°. This addition makes the charts far more complete, and it will be greatly appreciated by mariners and others. In some quarters the numerous wrecks occurring on the Newfoundland coast have been attributed to errors in the variation in that locality, but it is pointed out that it is sufficiently accurately determined for navigational purposes. The very variable currents experienced in the neighbourhood are the most probable cause of so many disasters, and during the prevalence of thick weather mariners are therefore urged on no account to neglect the use of the lead, as it is impossible to foretell with certainty how the current has been running, the prevailing southerly set being sometimes replaced by a north-going one, which would tend to drift a vessel up the coast between Cape Race and St. John's. Being midwinter, fog is by no means frequent on the banks, barely exceeding 10 per cent. of the weather observations. It is, however, interesting to notice that the season of least fog in the Newfoundland region is the season of greatest frequency of dense "red dust" clouds on the eastern side of the ocean, off Africa. Four years ago the Cape liners were delayed as much as three days by a thick dust fog, which extended for a distance of about 2000 miles southward from Madeira. The coasts of Trinidad and Guiana are at this season subject to rollers, which are dangerous to heavily laden small craft. There are some notes on the more salient features of the currents in various localities; the anti-cyclonic type of weather over western Europe is illustrated by an inset chart, the remarks showing that in January the barometer may rise as high as 31·1 in. within the British Isles; and the prevailing winds and the movements of the centres of cyclonic systems in the Mediterranean region during January are explained.

WE have received a copy of the tide table for Halifax, Quebec, St. John (N.B.) and Father Point, issued by the Tidal Survey branch of the Department of Marine and Fisheries, Canada, for the year 1902. This contains extended new information on the tides and currents of the St. Lawrence, based upon investigations made by the Tidal Survey in the season of 1900.

HERR H. WIECHEL contributes to the *Proceedings* of the "Isis" Natural History Society in Dresden an interesting paper on the ancient roads of Saxony. A sketch-map, elaborated from the "Oberreit'schen" atlas, which is based on the engineer surveys of about the year 1780, shows the chief roadways existing during the period A.D. 800 to 1200, and the paper discusses the routes, topographical names, &c., in detail.

UNTIL a few months ago, Tahiti could be reached from the United States only by a sailing schooner from San Francisco in a voyage of six or seven weeks. The French Government has now arranged for a steamship to leave San Francisco for Tahiti every five weeks, and as the voyage only lasts about eleven days, many travellers will probably take advantage of it. The development of means of communication will, however, produce decided changes in the ways and customs of the natives, and this induced Dr. S. P. Langley to visit Tahiti by the first trip of the new line. An interesting diary of the voyage and visit kept by him is printed, with illustrations, in the December number of the *National Geographic Magazine*. It will be remembered that Dr. Langley described in NATURE, of August 22 (vol. lxiv. p. 397), the fire-walk ceremony witnessed by him during his visit; and his observations showed conclusively that the alleged miraculous power of resisting fire possessed by the performers has no foundation in fact. The success of the fire-walk depends upon the low thermal conductivity of the stones among which the fire is kindled, as Dr. Langley explained in his letter to NATURE, and describes in his diary. Other ordeals by fire, which have been successfully undergone, such as the burning fiery furnace in which Shadrach, Meshach and Abednego stood unharmed could probably be explained by reference to natural causes in a similar way, if sufficient evidence were available.

IN a paper on "The Results of some Recent Researches in Electricity," published by the Warrington Literary and Philosophical Society, Mr. J. Reginald Ashworth has presented a summary of the properties of different kinds of rays in the following simple tabular form :—

Name of Ray.	Kathode.	Becquerel.	Röntgen.	Ultra-violet Light.	Red Light.
Existence of Interference, Polarisation, Reflection, Refraction.	o	o	o	×	×
Photographic Effect	×	×	×	×	o
Excite Phosphorescence	×	×	×	×	o
Render Air Conductive	×	×	×	×	o
Penetrate Opaque bodies	×	×	×	o	o
Undergo Deflection by Magnetism	×	×	o	o	o
Velocity relative to that of Light ...	¼	½	1	1	1

In this table × denotes the existence and o the non-existence of the several properties, and Mr. Ashworth quotes authorities for the statements as to the velocities of the rays.

IN a paper published in the *Verhandlungen* of the Naturforschenden Gesellschaft in Basle, Messrs. Paul and Fritz Sarasin suggest that the low temperature of a glacial period may be due to the obscuration of the sun's rays caused by large quantities of dust-particles suspended in the atmosphere. The phenomena associated with the Krakatoa eruption are discussed, and the widespread effects of this single eruption compared with what may be supposed to have been the result of volcanic activity on the scale known to have prevailed at the end of the Pliocene period.

PROF. W. M. DAVIS contributes a paper to the November number of *La Géographie* on the lessons of the Grand Cañon of Colorado. The conclusions arrived at by the author during a recent visit to this region, and published in the *Bulletin* of the Museum of Comparative Zoology at Harvard College, are used to elucidate its development, beginning with the formation of the *massif* of archæan rock which underlies it, and to show that the cutting of the great gorges is only the last, and by no means the longest, stage of a varied history. Prof. Davis again sets forth his view of the relations between geomorphology and geology, and urges the importance of the former as a branch of geography.

JUDGING from the *Schriften* for 1899, which has just reached us, the Natural History Society of Danzig seems to be in a flourishing condition, the number of papers in the volume before us being very large. Many are of a purely local nature, and some valuable contributions are made to the history of the fauna and flora of the district. Herr E. H. Rübsaämen describes, for instance, the insects and other arthropods obtained during two journeys in the Tuchel forest made in 1896 and 1897; while Herr F. Braun discourses on the ornithology of the Elbing range. Of wider interest is a paper, by Herr E. Treptow, on the progress and results of mining throughout the world during the nineteenth century. An elaborate table of the gold-production of the different countries of the world during the period in question is appended.

IN our last week's issue we noticed two papers from the *Proceedings* of the Philadelphia Academy, of which we had then received only some advance-sheets. The complete current issue (vol. liii. part ii.) has now reached us. Among the more important papers is one by Mr. J. A. G. Rehn on the earwigs, cockroaches, mantids and stick-insects collected by Dr. Donaldson Smith in north-east Africa. Altogether 239 specimens of Orthoptera were collected, of which the grasshoppers, crickets and locusts are reserved for a second paper. A considerable number of species are described as new. The author has also some notes on that remarkable South American bat known as *Centurio senex*, which is regarded as forming a subfamily by itself. In addition to the one on Liu-Kiu Clausilias referred to in our last issue, Mr. Pilsbry has several papers on new molluscs from Japan and the surrounding seas, in the first of which certain Liu-Kiu forms are also described. They are illustrated by several plates. Dr. H. C. Chapman's paper on the placenta and fœtus of the six-banded armadillo is also worthy of note. To ichthyologists Mr. H. W. Fowler's notes on type-specimens of fishes in the Academy's collection will be of interest.

NUMEROUS surveying and drawing instruments—some of a novel character—are mentioned and illustrated in the catalogue just issued by Messrs. W. F. Stanley and Co. Students of branches of engineering, architecture, and other subjects in which exactness of observation and design are required, will find that the catalogue contains many desirable instruments.

IT requires a philosophic spirit to read with patience and profit Mr. Howard Collins's "Epitome of the Synthetic Philosophy of Herbert Spencer." Yet the fifth edition of this summary of Mr. Spencer's completed and revised survey of the universe has now been published by Messrs. Williams and Norgate, thus showing that there are many students who find it of service. Broadly speaking, the book may be described as a collection of abstract propositions, the proofs of which will be found in the ten volumes in which "The Synthetic Philosophy" is elaborated. Mr. Collins manages to give the essence of this work in his volume of nearly 700 pages. "Indeed," remarks Mr. Spencer in a preface, "I have been somewhat surprised that it has proved possible to put so much in so small a space without sacrifice of intelligibility."

THE latest number of the *Proceedings* of the Society for Psychical Research contains 650 pages, in which Prof. J. H. Hyslop gives "A Further Record of Observations of Certain Trance Phenomena," the medium being Mrs. Piper. It need scarcely be said that many of the incidents and results described appear trivial to investigators more familiar with the material sciences than mediumistic performances. A special frame of mind is required even to consider the phenomena patiently.

There seems to be no suspicion of fraud in the case of the phenomena with which Prof. Hyslop is concerned, so that, accepting the observations as records of actual occurrences, an explanation of them is required. The physiologist might be able to throw some light upon them, but he is told that the problem has gone far beyond physiology. "Only the psychologist can any longer deal with the complexities and significance of the Piper phenomena." Telepathy with its necessary adjuncts is also thrown overboard, and spiritism is held to provide a sufficient hypothesis for the data in hand until a better supersedes it. Upon this view there must be a survival of consciousness after death, in a form which is incomprehensible to materialistic philosophers. Prof. Hyslop defines his position as follows:—"I have given a preference for the spiritistic theory in explanation of my alleged facts, in order to force the issue on an important investigation and in order to devolve upon those who have not accepted any supernormal phenomena at all the duty of rescuing me from illusion." Unfortunately, it is not possible for every investigator to study such psychical phenomena as those described by Prof. Hyslop and thus test the value of the observations, so he usually has little interest in them.

TWO papers on "La préparation industrielle et les principales applications des Gaz liquéfiés" are contributed by Prof. E. Mathias to the *Revue Générale des Sciences* of October 30 and November 15. Within the limits of twenty-eight pages of a review, much of that space being occupied by illustrations, it is impossible for the author to go deeply enough into the details of the subject to make his papers useful to those who have a fair acquaintance with them, and he does not always give the latest models of apparatus described by him. For general readers, however, the papers form a collection of facts and methods which will give them some insight into an interesting branch of work involving a clearer and closer connection than usual between scientific and industrial pursuits. In the first paper Prof. Mathias gives an account of various processes for liquefying the gases employed in refrigeration. In the second he describes and illustrates a number of machines in which the liquids are employed, and the purposes to which the results are or may be applied. In this connection it is to be regretted that the wild schemes of American company promoters are treated with so much respect, side by side with the descriptions of useful refrigerating machines being a serious account of two companies' automobiles designed to work with liquid air, with an illustration of one of them. The author does not give his readers fair guidance by stating that one of these companies is already in liquidation, and that neither of them has got better practical results than a specially arranged experimental run at a ruinous cost. Those who undertake to instruct the public in these matters with the voice of authority ought to make it clear that liquid air will be far too dear for employment as a source of power until an entirely new method of producing it is invented, and that no such method is as yet even in sight.

A CONSIDERABLE amount of work has been done recently on the ionising properties of liquefied gases, with especial reference to the hypothesis of the connection between the dielectric constant and the dissociating power. An interesting contribution by M. Centnerszwer to this field is contained in the current number of the *Zeitschrift für physikalische Chemie*, in which the conductivity of liquid cyanogen and of anhydrous hydrocyanic acid and of solutions of salts in these is given. In the case of cyanogen, the results of Gore, obtained in 1872, are extended and confirmed. Pure liquid cyanogen was found to have a scarcely measurable conductivity, its solvent power is very slight, and in no case could a proof of dissociation into ions be proved from the conductivity measurements. Liquid hydrocyanic acid proved to have a measurable conductivity, which varied, however, in different experiments. Conductivity measurements were successfully carried out with solutions of potassium iodide and trimethylsulphine iodide, with the result that the solutions were found to possess about four times the conductivity of aqueous solutions of the same salts at equal temperatures and concentrations. In connection with the high value of the dielectric constant, these results furnish a new confirmation of the views of Thomson and Nernst on the parallelism between the dielectric constant and dissociating power.

TYCHO BRAHE IN PRAGUE.[1]

THE two papers mentioned below were published by the Bohemian Society of Science on the occasion of the 300th anniversary of Tycho's death. The first one forms a continuation of Prof. Studnicka's "Prager Tychoniana," published about a year ago (NATURE, lxiii. p. 206), and gives the titles of about a dozen volumes from Tycho's library which now belong to the University library at Prague. Several of these volumes contain three or four books bound together, with a few leaves of MS. inserted, among which is a MS. of eight pages (reproduced in facsimile) containing the calculation of the horoscope of Andreas Schoner, who is stated to have been born at Nuremberg on June 21, 1530. This is of interest, not only as showing the various steps of the *modus operandi* of judicial astrology, but also because the date of the younger Schoner's birth has hitherto been unknown (Poggendorff only gives the year 1528). In another volume of mathematical books there is a MS. note to the effect that $\pi = 88 : \sqrt{785}$, which value ($= 3{\cdot}1409$) does not seem to occur elsewhere. On the title page of this memoir is a figure of a medal which Tycho caused to be struck in 1595, probably to commemorate the completion of his star catalogue.

The second paper contains a report on the examination of Tycho Brahe's tomb in the Teyn Church at Prague in June last and on the state of his remains. As it was known that the bodies of some Protestants had been removed from the church after the battle of Prague in 1620 (though nobody has ever alleged that Tycho's tomb had been disturbed), the municipality of Prague allowed the tomb to be opened in order to ascertain whether the great astronomer's bones were still in it. On opening the floor of the church the vault was found to have partly fallen in, so that the two coffins were completely covered with débris and rubbish. We learn from another account (in the journal *Das Weltall*) that this is supposed to have happened in 1679, when part of the roof of the church took fire and fell down after being struck by lightning. The two coffins, which were falling to decay, contained the skeletons of a man and a woman, obviously Tycho and his wife, and slight remains of clothing on the former. Tycho's bones were taken out and put in a box in the vestry until a new metal coffin could be provided, but the writer of the report carried off the front part of Tycho's skull (all that was left of it) in order to examine, measure and clean it, whereby he found that the nose showed distinct signs of having been damaged (in the duel in Tycho's youth), while the green colour of the edges of the injured part no doubt was caused by some composition of copper in the false nose, which in course of time had been completely dissolved. Two illustrations give front and side views of the face, and the account *Das Weltall* gives pictures of the same before and after the cleaning of the remains. Though we are assured in a footnote that everything was done in a dignified manner, this part of the report is painful to read and reminds one too much of the custom in ancient Brittany, where the inhabitants at the solstices or on the anniversary of the death of a relative took his bones out of the tribal ossuary, scraped them and put them back again. The whole proceeding may possibly have been interesting to an anthropologist (though Tycho did not belong to an extinct or otherwise peculiar race), but we think astronomers will be glad to know that their colleagues at the Prague Observatory had no part in this investigation.

[1] *Bericht über die astrologischen Studien des Reformators der beobachtenden Astronomie Tycho Brahe.* Von F. J. Studnička. Pp. 54. (Prag 1901.)

Bericht über die Untersuchung der Gebeine Tycho Brahe's. Von D H. Matiegka. Pp. 14. (Prag, 1901.)

EXPERIMENTAL PHONETICS.[1]

THE movements of the organs of voice and speech are so complicated as to require for their elucidation the application of many methods of research. When one speaks there are movements of the lips, tongue, soft palate and larynx, and sometimes movements of the muscles of expression. Then, again, there are special characteristics about vowel sounds which apparently distinguish these from the sounds of musical instruments. Thus questions arise as to the true nature of vowel-sounds and as to what is the physical constitution of a word of several syllables. It has also been suggested that language might be recorded, not by letters or syllables, but by signs or symbols which would indicate what had to be done by the vocal and articulating organs for the production of any given sound. There might thus be a physiological method of expressing speech by a series of alphabetical symbols for sounds varying in pitch, intensity and quality. It will be seen that experimental phonetics constitutes a wide field of research, not only of great scientific interest, but also one having practical aspects not at first apparent. From the nature of the investigation, also, the problems seem to be specially suited for the application of the graphic method of research.

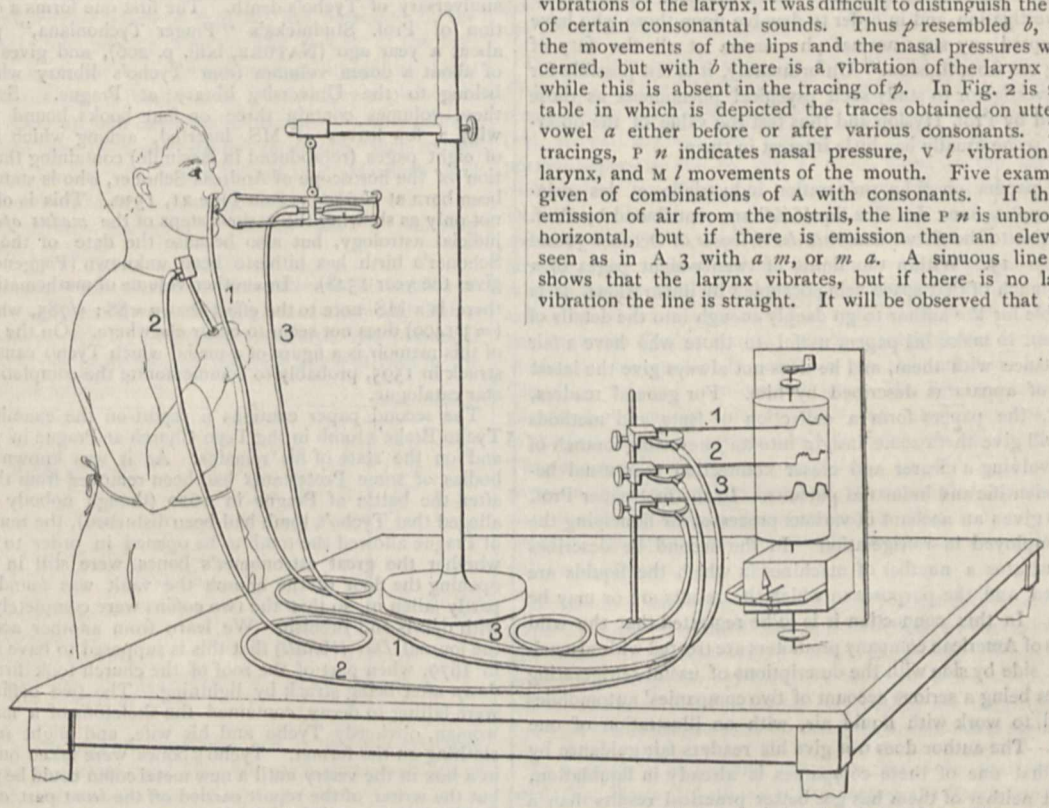


FIG. 1.—A method for recording simultaneously the different acts of speech: emission of air by the nares (tube and lever, 1) vibrations of the larynx (2), and movements of the lips (3).

In 1875, an investigation was carried out by Havet and Rosapelly[2] in the laboratory of Prof. Marey in Paris, in which the pressure of the air in the nose, the movements of the lips, and the vibrations of the larynx were simultaneously recorded. Special contrivances were devised for transmitting these movements to three of Marey's tambours, so arranged as to record on the surface of a blackened drum three superposed curves which indicated the order of succession, duration and intensity of the movements of the organs. The emission of air from the nostril indicated movements of the soft palate, and these were signalled by an indiarubber tube introduced into one nostril while the other end was connected with a tambour, as in Fig. 1. A small electromagnetic apparatus was placed over the larynx, and by making and breaking a current the vibrations of the larynx were transmitted to another tambour. The movements of the lips were recorded by a device which caused the pressures to act on a third tambour, as is shown in the figure.

This method was found to give characteristic tracings for the sounds of consonants, but the records obtained from vowel-sounds were all very much alike. It was also observed that if one of the tambours did not act, say the one recording the vibrations of the larynx, it was difficult to distinguish the tracings of certain consonantal sounds. Thus *p* resembled *b*, so far as the movements of the lips and the nasal pressures were concerned, but with *b* there is a vibration of the larynx as well, while this is absent in the tracing of *p*. In Fig. 2 is shown a table in which is depicted the traces obtained on uttering the vowel *a* either before or after various consonants. In these tracings, P *n* indicates nasal pressure, V *l* vibrations of the larynx, and M *l* movements of the mouth. Five examples are given of combinations of A with consonants. If there is no emission of air from the nostrils, the line P *n* is unbroken and horizontal, but if there is emission then an elevation is seen as in A 3 with *a m*, or *m a*. A sinuous line in V *l* shows that the larynx vibrates, but if there is no laryngeal vibration the line is straight. It will be observed that in some cases the larynx vibrates throughout all the experiment, as in A 2, while in others there is an interruption, as in B 1. The movements of the lips in M *l* show a curve which varies in amplitude and duration according as the lips are more or less approximated and according to the duration of complete or partial occlusion.

These syllabic sounds may be termed *phones*. This research is an excellent example of the application of the graphic method to the movements of speech. The method has been much developed by Rousselot[1] in the Collège de France, where there now exists a special laboratory for research in phonetics.

Prof. Marey, whose earlier researches are well known to have had much to do with the development of the kinematograph, employed, so long ago as 1888, chronophotography to catch those evanescent changes of the countenance, the sum total of which give expression to the face in speech. In Fig. 3 are seen the changes of expression in a woman's face in speaking, during a period of half a second. If these successive pictures are projected by a lantern (Fig. 4) there is an animated face on the screen. In this way Marichelle succeeds in placing before the

[1] By Prof. John G. M'Kendrick, F.R.S. Read before the Section of Physiology at the meeting of the British Association in Glasgow, September 13. "Die Phonetische Literatur von 1876–1895." By Hermann Breymann (Leipzig, 1897); "The Articulation of Speech Sounds by Analphabetic Symbols." By Otto Jespersen (Marburg, 1889): "L'Inscription des Phénomènes Phonétique." By M. J. Marey (*Revue Générale des Sciences*, 15 et 30 Juin, 1898); "Studies from the Yale Psychological Laboratory." By E. W. Scripture (1899); "Théorie de la Formation des Voyelles." By Marage (Paris, prix Barbier, 1900); "La Parole d'après le Tracé du Phonographe." By H. Marichelle (Paris, 1897); "On Vowel Sounds." By J. G. M'Kendrick and A. A. Gray, Schäfer's "Text-Book of Physiology," vol. ii. p. 1206, in which the recent bibliography is given in detail.

[2] Rosapelly: "Inscription des Movements Phonétiques," in "Travaux de Laboratoire de M. Marey" (Paris, 1875).

[1] Rousselot: "Principes de Phonétique Expérimentale" (Paris, 1897).

eyes of deaf mutes images of the movements of speech which they are urged to imitate.

It is interesting, in the next place, to trace the efforts that have been made by physicists and physiologists to record the pressures produced by sound waves and more especially those of the voice. In 1858, Leon Scott invented the phonautograph, seen in Fig. 5. In its first form this instrument gave very imperfect tracings, but it is of great interest as being the forerunner of the phonograph. It was much improved by Rudolph König, of Paris. Donders,[1] in 1868, was the first to use the instrument in the investigation of vowel-tone. Then came the logograph of Barlow[2] in 1876, which was a membrane furnished with a rigid but light lever having its fulcrum at the edge of the membrane while the power was applied from the centre of the membrane. This gave more accurate tracings, that is to say, tracings that indicated with more precision the variations of pressure on the membrane. Examples are given in Figs. 6, 7, and 8.

In Fig. 6 at A the membrane is at rest; at B the lever is raised by the sudden emission of the consonant *b*, and this is succeeded by the prolonged vibration of the vowel *e*. Fig. 7 gives a different picture for *e b*; A is the vowel *e*; B the closure of the lips at the beginning of the consonant; this closure lasts during C, and D is due to the elasticity of the air compressed in the mouth. In Fig. 8, *b e b*, we find the elements of Figs. 6 and 7. By the logograph the consonantal sounds were alone depicted, the records of the vowels being very imperfect.

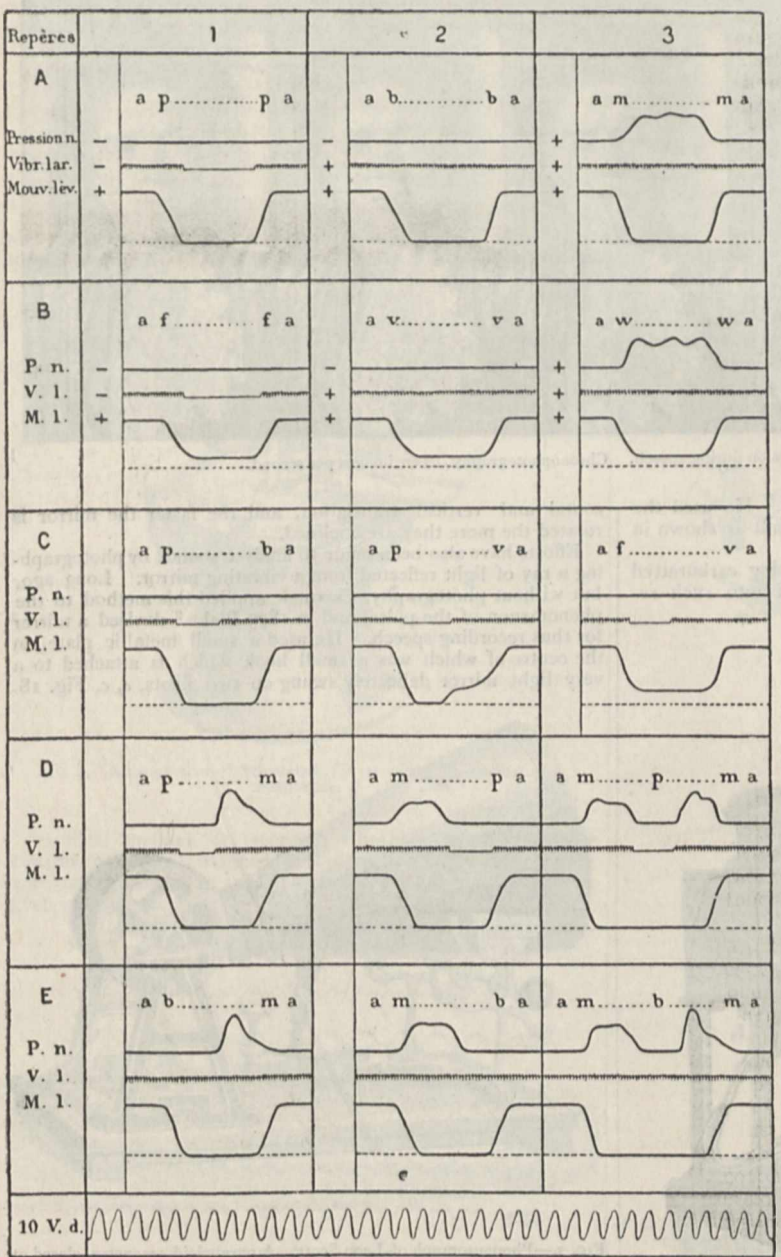


FIG. 2.—Tracings of nasal, laryngeal and labial movements in the pronunciation of various phones.

There was still a demand for a recorder of greater accuracy. Schneebeli,[1] in 1878, devised an instrument seen in Fig. 9. From the centre of a parchment membrane arises a thin but rigid steel plate; attached to this, near the point, is another steel plate passing horizontally from the edge of the metallic ring carrying the membrane. The movements of the membrane are five times increased in amplitude, while the extreme lightness of the lever reduces to a minimum the effects due to inertia. Examples of curves obtained by this method are shown in Fig. 10.

A very sensitive apparatus, termed the *Sprachzeichner*, has also been introduced by Hensen[2] for recording the delicate vibrations of a membrane. It will be readily understood by referring to Figs. 11, 12 and 13. Valuable observations have been made with the aid of this instrument by Wendeler,[3] on consonant sounds, by Martens,[4] on vowels and diphthongs, and by Pipping,[5] on vowels.

Such are some of the mechanical contrivances that have been devised for recording the movements of a membrane. None are free from error, however delicate they may seem to be, owing to the inertia of the parts, and consequently other arrangements were demanded. In 1862[6] Rudolph König introduced his well-known method of showing the movements of membranes by manometric flames. The apparatus is now so well known as to require no detailed description. Gas is led by a tube into a small capsule of wood, the cavity of which is divided by a thin membrane (Fig. 14, A). The gas passes into the right half of the cavity and escapes into a small burner, where it is lit. If sound waves are diverted by a small conical resonator into the left half of the capsule the membranous partition vibrates, there are alternations of compression and of rarefaction in the gas on the right side, and the flame is agitated, moving upwards and downwards with each vibration. The method of Wheatstone of dissociating the flames by a rotating mirror is then employed, and a sinuous ribbon is seen in the mirror. The ribbon is cut vertically into teeth, some larger, some smaller. The larger, less frequent, correspond to the

1 Donders: "Zur Klangfarbe der Vocale" (*Ann. der Physik und Chemie*, 1868).

2 Barlow: "On the Articulation of the Human Voice, as Illustrate by the Logograph" (*Trans.* Roy. Soc. 1876).

1 Société des Sciénces Naturelles de Neuchâtel, 25 Avril et 20 Novembre, 1878.

2 Hensen: "Ueber der Schrift von Schallbewegungen" (*Zeits. für Biologie*, 1887).

3 Wendeler: "Ein Versuch über die Schallbewegungen einiger Konsonanten" (*Zeits. für Biologie*, 1886).

4 Martens: "Ueber des Verhalten von Vocalen und Diphtongen in Zesprochenen Worten" (*Zeits. für Biologie*, 1889).

5 Pipping: "Zur Klangfarbe der Gesungen Vocale" (*Zeits. für Biologie*, 1890); "Ueber die Theorie der Vocale" (*Arta Societatis Scientiarum Helsingfors*, 1894).

6 König: "Quelques Experiences d'Acoustique (Paris, 1882).

fundamental tone of the sound, the smaller to the harmonics that enter into the composition of the compound tone on which the quality of the vowel depends.

These flame pictures are only seen for an instant, and many efforts have been made to fix them by photographic methods.

FIG. 3.—Changes of expression during speech. Chronophotography. Ten images per second.

This was first attempted by Gerhardt [1] in 1877. He used the flame of cyanogen, and the somewhat poor result is shown in Fig. 16.

Doumer [2] obtained a brilliant flame by burning carburetted hydrogen in oxygen, and he also introduced into such researches a chronophotographic method by reproducing the images of a flame acted on by a tuning-fork of known pitch.

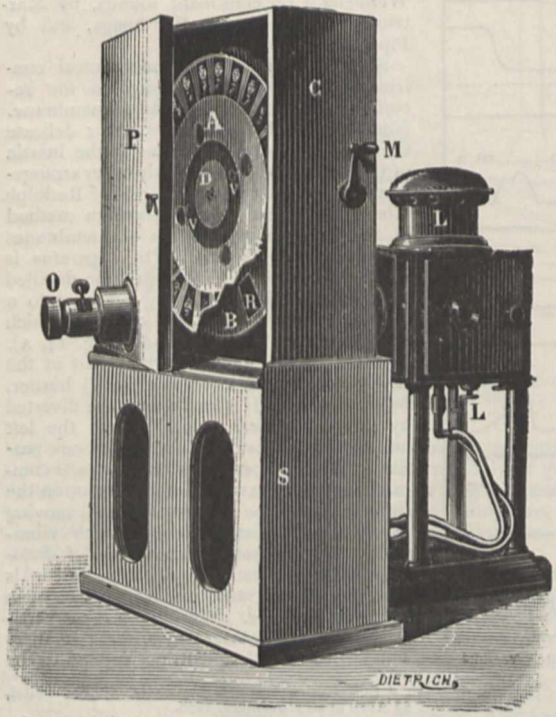


FIG. 4.—Photophone of Demeny. A, glass disc carrying the pictures; B, another disc, perforated; L, electric lamp; O, lens.

[1] Stein: "Die Licht im Dienste wissenschaftlicher Forschung." (Leipsig, 1877).

[2] Doumer: *C.R.* de l'Académie des Sciences, 1886.

Marage,[1] to whose researches we shall afterwards refer, feeds the capsule with acetylene, and thus obtains a luminous flame. The result of such an arrangement is shown in Fig. 17.

It will be observed that all manometric flames seen in a rotating mirror are inclined, as their composition is due to a horizontal and vertical translation, and the faster the mirror is rotated the more they are inclined.

Efforts have also been made to analyse sounds by photographing a ray of light reflected from a vibrating mirror. Long ago, but without photography, Czermak applied this method to the phenomenon of the pulse, and in 1879 Blake [2] devised a mirror for thus recording speech. He used a small metallic plate, in the centre of which was a small hook which is attached to a very light mirror delicately swung on two pivots, *c*, *c*, Fig. 18.

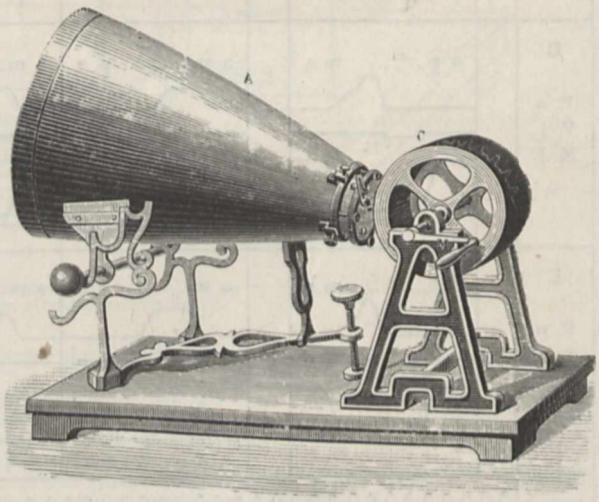


FIG. 5.—Phonautograph of Leon Scott. A paraboloid resonator, closed at one end by a membrane, to which a light lever is attached. C is a drum covered with smoked paper on which the lever traces a curve. As C rotates, it moves from right to left.

A ray of light is thrown on the mirror by a convex lens; after reflection it again traverses a lens and falls on a photographic plate in movement. Sharp, well-defined images are thus obtained (Fig. 19).

[1] Marage: "Étude des Cornet Acoustiques par la Photographie des Flammes Manometriques de König" (1897).

[2] Blake: *American Journal of Science and Art*, 1878.; *Journal de Physique*, 1879.

The amplitudes of the tracings thus obtained from the tones of the voice were 0^m, 025 (1 inch), while those of the mirror were only 0^{mm}, 125 (1/200th inch).

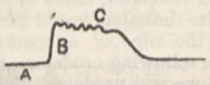


FIG. 6.—Tracings of the sound *b e*.

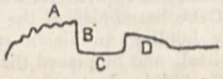


FIG. 7.—The sound *e b*.

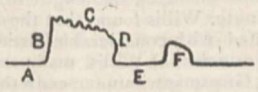


FIG. 8.—The sound *b e b*.

Rigollot and Chavanon,[1] in 1883, constructed a mirror-apparatus shown in Fig. 20, and Hermann,[2] in 1889, used a somewhat similar arrangement, the tracings of which are given in Fig. 21.

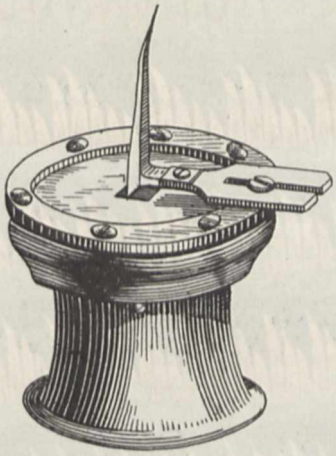


FIG. 9.—Arrangement of Schneebeli for recording movements of a membrane.

An ideal method for recording vibrations was devised by Rops in 1893, ideal inasmuch as it does not use any vibrating membrane or lever, or anything having inertia. A diagram is given in Fig. 22.

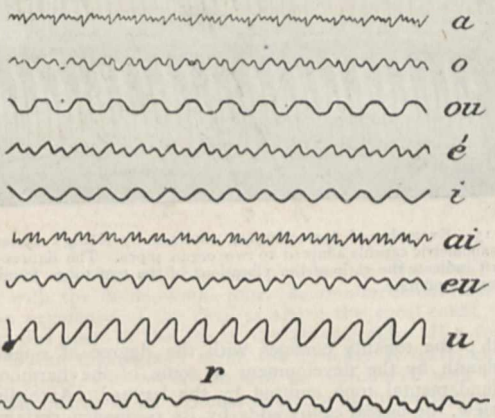


FIG. 10.—Curves of various vowels and of the consonant *r* recorded by the apparatus of Schneebeli.

It is based on the principle of photographing the effects of interferences of light waves. Rays from a luminous source A pass through the lenses *q q* so as to become parallel. They then pass through a slit *d* and a hole in a diaphragm *b*, and they are focussed by a lens *l* (of 15 centimetres focal length) so as to fall on a glass plate s_1. The ray divides into two, a_1 and a_2, and they run parallel, the ray a_1 passing through the air while a_2 passes along a tube *g* (15 centimetres in length), the ends of which are closed by the glass plates *h* and h_1. A few centimetres from the tube there is a resonator, *i*, into which the vowels are sung, thus causing condensations and rarefactions of the air,

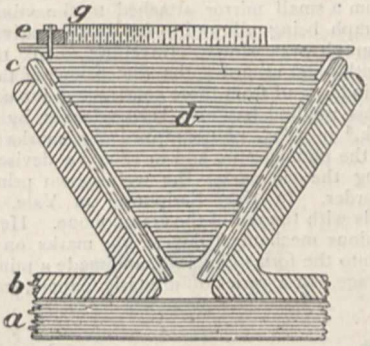


FIG. 11.—Apparatus of Hensen. *d*, Wooden prism; *e*, glass; *g*, smoked glass kept in its place by a screw clamp, *c*; *a*, *b*, supports.

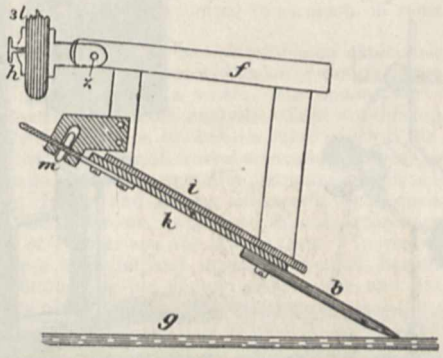


FIG. 12.—The recording portion of the Sprachzeichner of Hensen. *f*, *i*, frame having a joint, *z*; *b*, wooden point; *g*, smoked glass.

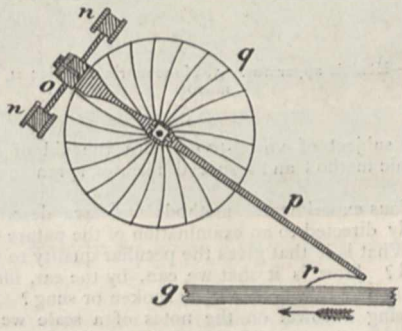


FIG. 13.—Writing portion of Hensen's apparatus. *n*, *n*, weights supporting an axis *o*, carrying marker *p*, with a point *r*; *q*, a disc communicating to the marker *p* the movements of the membrane; *g*, smoked glass plate.

disturbing the ray $h\ h_1$, while the ray passing through the tube *g* is unaffected. The two rays are again united by s_1; they then pass through an objective *c* and a lens *z* to a slit in a screen so as to fall on sensitive paper on the drum T. A diaphragm *b* cuts off secondary reflections. Thus beautiful images are formed corresponding to the vowels spoken or chanted into the resonator.

The invention of the tinfoil phonograph by Edison in 1877, and the improvement of the instrument by the labours of Edison,

[1] *Journal de Physique*, 1883.
[2] Hermann: *Pflüger's Archiv*, 1889.

Graham Bell and others in more recent years, has made it possible to investigate phonetic phenomena with the aid of this instrument. In 1878 Fleeming Jenkin and Ewing[1] devised a method of recording curves from the imprints on the tinfoil covering the drum of the phonograph, and these curves were submitted to harmonic analysis. This was also attempted by A. M. Mayer[2] in the same year. The subject was taken up by Hermann[3] about 1890, and he obtained valuable tracings by using the wax-cylinder phonograph. He succeeded in obtaining photographs of the curves on the wax cylinder, a beam of light reflected from a small mirror attached to the vibrating disc of the phonograph being allowed to fall on a sensitive plate while the phonograph was slowly travelling. In 1891 Boeke[4] measured with great accuracy the dimensions of the marks on the wax cylinder, and from these constructed the corresponding curves. This method has also been adopted by Marichelle.[5] McKendrick,[6] in 1895, photographed the marks on the wax cylinder of the phonograph, and in 1896 he devised a recorder for enlarging the curves on the well-known principle of the syphon recorder. In 1899 Scripture,[7] of Yale, investigated vowel-sounds with the aid of the gramophone. He transcribed, by an ingenious mechanical device, the marks on the gramophone disc into the forms of curves, and made a minute analysis. Lastly, Marage,[8] in a series of masterly papers, reinvestigated

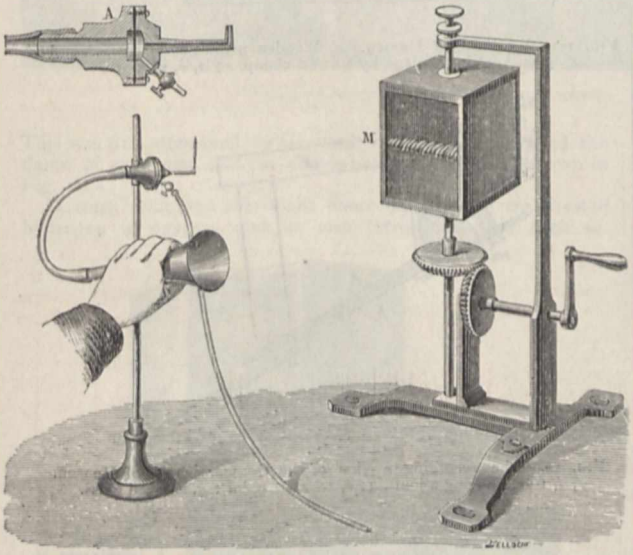


FIG. 14.—König's apparatus. A, Manometric capsule; M, rotating mirror.

the whole subject of vowel-tones with the aid of a chronophotographic method and a special form of syren invented by himself.

The various experimental methods we have described have been chiefly directed to an examination of the nature of vowel-sounds. What is it that gives the peculiar quality to the sound of a vowel? How is it that we can, by the ear, identify the sound of any vowel, whether it be spoken or sung? How is it that if we sing a vowel on the notes of a scale we can still identify the vowel, whatever may be the pitch of the note on which it is sung? The scientific investigation of the nature of vowels begins with Willis,[1] who, in 1829, imitated the larynx by means of a reed, above which he placed a resonator, tuned to one of the harmonics of the reed. He also imitated vowel-tones by holding an elastic spring against the edge of a toothed wheel, and he placed the vowels in the following order—*ou*, *o*, *a*, *e* and *i*. In each case a compound tone was produced which retained the same pitch so long as the wheel revolved at the same rate. By keeping the wheel revolving at a uniform rate, and at the same time changing the length of the spring which was allowed to vibrate, Willis found that the qualities of various vowels were imitated with considerable distinctness. In 1837 Wheatstone,[2] in a criticism of Willis, made some important suggestions. In 1854 Grassmann[3] announced a theory as follows:—The vocal cords excite the resonances of the cavity of the

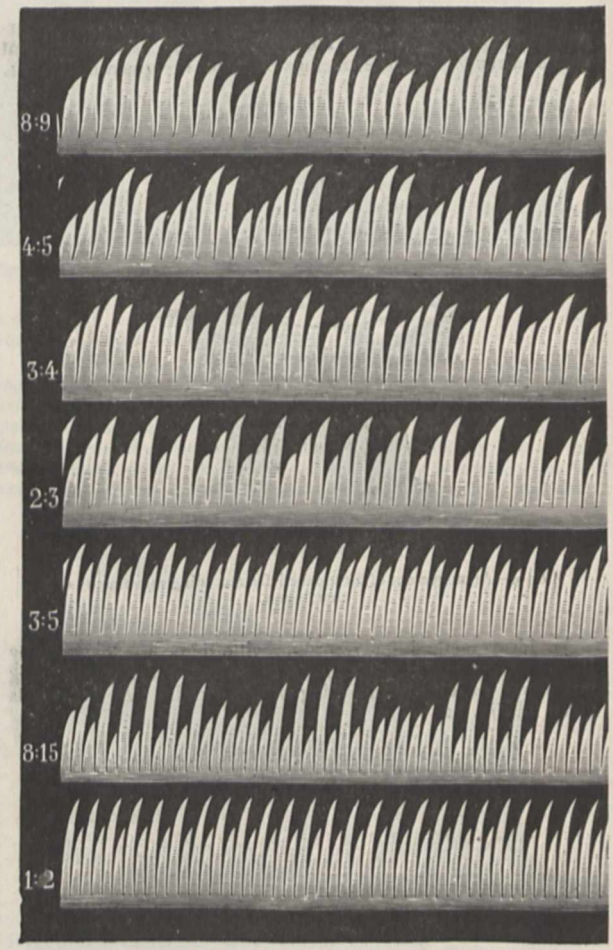


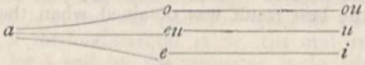
FIG. 15.—Examples of flame-pictures obtained by König's system of a manometric capsule adapted to two organ pipes. The figures to the left indicate the ratio of the vibrations of the two tones forming the compound tone.

mouth; the tonality changes with the degree of opening of the mouth by the development of some of the harmonics of the fundamental tone emitted by the larynx. According to this view, the buccal cavity adds by its resonance certain harmonics to the fundamental laryngeal sound. Grassmann classified

1 Fleeming Jenkin and Ewing: "On the Harmonic Analysis of certain Vowel Sounds" (*Trans.* Roy. Soc. Edin., vol. xxviii. p. 745).
2 Mayer: *Journal de Physique*, 1878.
3 A full bibliographical reference to Hermann's papers is given in Schäfer's "Text-Book of Physiology," vol. ii. p. 1222.
4 Boeke: "Microscopische Phonogrammstudien" (*Archiv* f. d. ges. Physiol., Bonn, Bd. i. S. 297; also *Proc.* Roy. Soc. Edin., 1898.)
5 Marichelle: "La Parole d'après le Tracé du Phonographe" (1897).
6 McKendrick: *Trans.* Roy. Soc. Edin., vol. xxxviii. pt. iv.; *Proc.* Roy. Soc. Edin., 1896-97; also "Sound-Waves as Revealed by the Phonograph" (London, 1897.)
7 Scripture: "Studies from the Yale Psychological Laboratory" (1899.)
8 Marage: "Comment parlent les Phonographes"; "Les Exercises Acoustiques chez Les Sourds-Muets"; "Rôle de la chaîne des osselets dans l'Audition"; and "Théorie de la Formation des Voyelles" (from 1897 onwards).

1 Willis: Cambridge *Phil. Trans.*, 1829, vol. iii. p. 231: also *Ann. d. Phys. u. chem.*, Leipsig, Bd. xxiv. p. 397.
2 Wheatstone, *Westminster Review*, October 1837.
3 Grassmann, "Über die physik. Natur der Sprachleute," 1877; he had, however, in 1854, enunciated his theory in "Uebersicht der Akustik u. der niedem Optik."

the vowels according to the number of harmonics which they contained, in the following table :—



In sounding *a* the mouth is widely opened and the fundamental and eight harmonics are produced ; in the third series, on the contrary, there is only one harmonic sounded, which is more and more acute as we pronounce the vowels in the order *ou*, *u* and *i*. The vowels of the second series, *o*, *eu* and *e*, are transitional between the first and the third. Thus we pass from *a* to *ou* by *o*, from *a* to *u* by *eu*, and from *a* to *i* by *e*.

Donders[1] showed that the cavity of the mouth, as arranged for the giving forth of a vowel, was tuned as a resonator for a tone of a certain pitch, and that different pitches coresponded

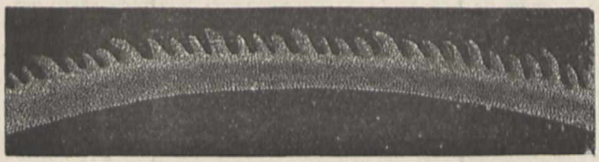


FIG. 16.—Vibrating flame of cyanogen photographed by Gerhardt.

to the forms of the cavity for the different vowels. This he discovered by the peculiar noise produced in the mouth when the different vowels are whispered. The cavity of the mouth is then blown like an organ-pipe and by its resonance reinforces the corresponding partials in the rushing wind-like noise. Then the question was taken up by Helmholtz.[2] He attacked it both by analysis and by synthesis. He analysed the vowel-tones by his well-known resonators, aided by his own singularly acute ear, and he attempted to combine, by means of tuning-forks, the tones which he thought existed in a vowel, so as to reproduce the sound of the vowel. In the latter part of the investigation he was by no means successful. These investigations led Helmholtz to put forward in succession two theories as to the formation of vowels. The first was that, as in all musical instruments, the quality or timbre of the vowel depends on the fundamental tone, reinforced by certain partials or over-

soon after its invention. Donders sang the vowel tones to the instrument, and then asked the operator to vary the speed of the cylinder during reproduction. Then the vowel *a* became *o*, and *e* became *ou*. Thus while the phonograph reproduces in a wonderful way the tones of musical instruments without change of quality, it cannot transpose vowel-tones without altering their character. This special character or quality cannot, then, depend on the overtones reinforced by the oral cavities being simple multiples of the fundamental tone, and Helmholtz's first theory had to be abandoned.

This led Helmholtz to advance a second theory as follows :—Each vowel is characterised by a certain harmonic or partial tone, of constant pitch, whatever may be the pitch of the note on which the vowel is sung or spoken. Attempts were then made, notably by Helmholtz and König, to fix the pitch of the characteristic partial tone or vocable, and there appeared to be

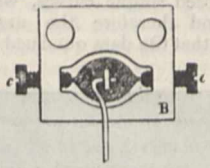


FIG. 18.—Blake's mirror

considerable differences in the results of the two distinguished observers, differences amounting to as much, in some cases, as three semi-tones.

The next step was, as has already been explained, to transcribe the marks on the wax cylinder of the phonograph, made on singing or speaking a vowel, into sinuous curves and to subject these to harmonic analysis. It is not difficult, in comparatively simple cases, to obtain a curve which is the algebraic sum of the ordinates of several sinusoidal curves, but it is not so easy to do the reverse operation, namely, to analyse the curves. Fleeming Jenkin and Ewing, afterwards Schneebeli, Hensen, Pipping and Hermann, have done this in accordance with the theorem of Fourier and the law of Ohm. In particular, Hermann, by a beautiful and ingenious method, has analysed the curves obtained by his photographic device, and has modified the theory of Helmholtz. His statement is that the oral cavity

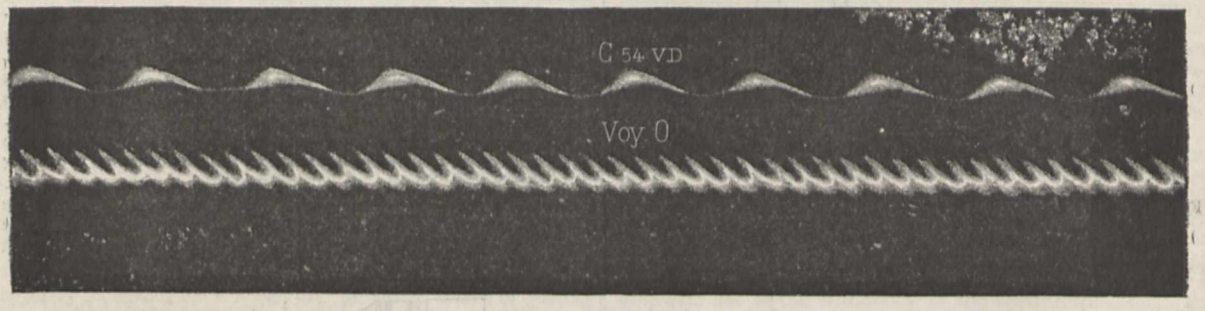


FIG. 17.—Photograph of manometric flames of acetylene showing vibrations of vowel o. Above are the images of chronographic flames—54 double vibrations per second.

tones, of which a number are produced by the vocal cords along with the fundamental tone, the reinforcement depending on the resonance of the cavities above the vocal cords. This theory was upset by the use of the phonograph. If a vowel is sung to the phonograph while the cylinder is travelling at a certain speed, the vowel-tone will be reproduced with exactly the same quality if the cylinder is driven at the same speed, but if it is driven faster, then the quality of the vowel will be changed, so much so as to be scarcely recognisable. M. Marey narrates that Donders and he first made this observation when it so happened that the two savants were present in Paris at a public demonstration of the phonograph

produces independently a harmonic or partial tone which has no definite relation to the fundamental tone emitted by the larynx. A vowel, according to him, is a special acoustic phenomenon, depending on the intermittent production of a special partial, or "formant," or "characteristique." The pitch of the "formant" may vary a little without altering the character of the vowel. For *a*, for example, the "formant" may vary from fa_4 to la_4, even in the same person. He has also attempted, but not with complete success, to reproduce the vowel-tones by synthesis.

There are thus three theories : (1) the first of Helmholtz, now abandoned, that the pitch of the partials is represented by simple multiples of the vibration periods of the fundamental ; (2) the second of Helmholtz, that the pitch of the characteristic partial is always fixed, but has a definite relation to the pitch of the fundamental ; and (3) that of Hermann, that the pitch

[1] Donders : "De physiologie der Spraakklanken" (1870).

[2] Helmholtz : "Ueber de Vokale." *Archiv.* f. d. Holland. Beitr. 2, Nat. u. Heilk. (Utrecht, 1857). See other references given in Schäfer's "Text-Book," vol. ii. p. 1217 (footnote).

of the characteristic partial or "formant" is not absolutely fixed.

The difficulty of harmonising these theories has stimulated the zeal of many workers, and in particular Dr. Marage[1] has been remarkably successful in his researches into the nature of vowels. He first of all criticises the second theory of Helmholtz, pointing out that the failure to reproduce the vowels by synthesis is strongly against it. Thus while, by tuning-forks, the pitch of which is that of the partials of the fundamental tone, *ou*, *o* and *a* may be badly reproduced, it has been found impossible to reproduce E and I. He then objects to the theory of Hermann, namely, that the vowel is an oral intermittent and oscillating tone; first, that the method of recording the vowel on the wax cylinder of the phonograph causes grave errors, because the mouthpiece, tube, air chamber and vibrating disc all profoundly modify the vowel; second, that the method of analysis by Fourier's theorem assumes that the vowel curves are constituted by superposed simple curves, which is precisely the question at issue, and therefore the argument is a *petitio principii*; and third, that the data obtained by his method have

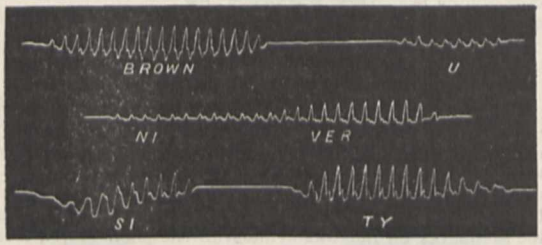


FIG. 19.—Photographic tracings obtained by Blake's method.

not enabled Hermann to reconstruct the vowels with greater success than Helmholtz. Marage then enters upon his own method, which consists essentially of using a special apparatus constructed on König's principle of manometric flames, but so

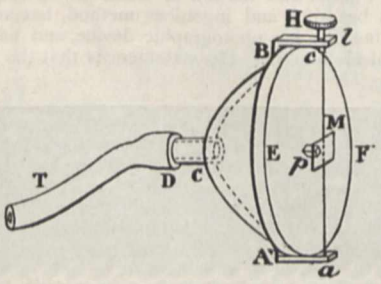


FIG. 20.—Palmoptic capsule of Rigollot and Chavanon (παλμικος, pertaining to vibrations). E F, collodion membrane; M, mirror carried by a wire *a c*, stretched between supports A and B, and regulated by the screw H; *p*, small cube of india-rubber resting on centre of membrane; T, tube.

simple as to be practically free from sources of error; that is to say, there is no mouthpiece, tube or lever. The pictures of the flames were produced photographically by feeding the flame with acetylene gas, and chronophotometrical records were taken with each experiment. He then finds that the flame pictures of I, U and OU show *one* flame, E, EU and O two flames, and A three flames. So that the classification of the vowels by flames is exactly that of Grassmann. Each vowel, when all errors have thus been got rid of by simplifying the apparatus, always gives the same picture for any given note. The picture is that of a continuous periodic curve, and the number of periods in a second corresponds to the laryngeal note, while the *form* of the period characterises the vowel. With the same vowel the period changes with the note. When the note is near the pitch of ordinary speech, the period varies very little. This is not so when the vowel is sung; the period then disappears until there is only the laryngeal note. Marage has also by synthesis reproduced the vowels with remarkable success. His first experiments with resonators were not quite satisfactory; he could reproduce OU, O and A, but not E and I. He ascertained, however, that to reproduce A the resonator must be tuned to the third harmonic or partial of the note on which A was sung; that to reproduce E, EU and O the best result was obtained when the resonator

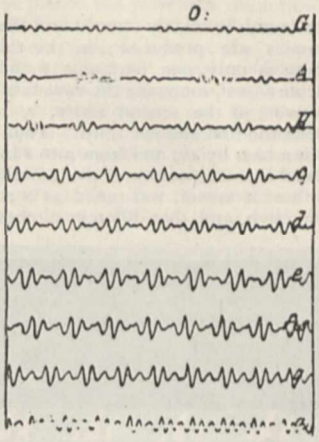


FIG. 21.—Tracings obtained by Hermann of vowel O.

gave the second partial; and I, U and OU were imitated (but not successfully) when the resonator was in unison with the laryngeal tone.

Marage finally devised a syren rotated by an electric motor and consisting of a disc having in it a triangular window representing the glottis. The air is driven under pressure through this aperture and then falls on another disc having windows cut out of it in groups according to the nature of the vowel to be synthetically reproduced. Thus the disc for A has four groups, each group consisting of three triangular slit-like windows; for O and E the disc shows five groups, each consisting of two slits; and for I and OU there are many slits, without these being arranged in groups. The slits are very large for O and narrow for E, and large for OU and narrow for I. He then moulded a series of casts of the interior of the oral and pharyngeal cavities of a human subject, as these were adapted for the singing of the different vowels, and from them constructed masks or head-pieces which could be placed over the syren so that the air escaping from it passed through the cavities of the mask. He found that if air was driven through the masks under a pressure of only 7 centimetres of water, the timbre of the corresponding vowel was at once perceived, as in whispering. Marage's view is that to form a vowel the true vocal cords vibrate in a horizontal plane, in such a way as to influence by their greater or less degree of approximation the escape of air.

If the air escapes in three little puffs as it were (the cords vibrating during each puff a number of times equal to the pitch of the note on which the vowel is spoken or sung), so that

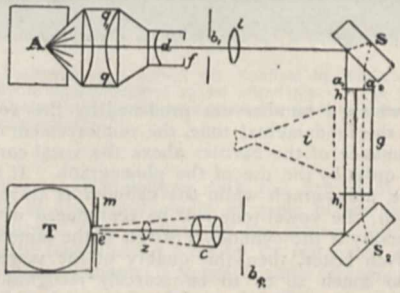


FIG. 22.—Rops' apparatus for the analysis of vowel-tones.

there are intervals between the groups of puffs, then the vowel A is the result. The oral resonator is in unison with the sum of the vibrations and the vowel is emitted. If the resonator (either artificial or the oral cavity, as in life) is turned to the

[1] Marage: "Théorie de la Formation des Voyelles," *op. cit.*

third harmonic of this note, then the vowel A is modified; the same applies to E and O, which have the second harmonic, and in passing from the one vowel to the other it is sufficient to change the aperture of the glottic opening. Thus for A, if the fundamental note is n, the oral resonator must be tuned to $3n$; for E and O, if the fundamental is n', the oral resonator gives $2n'$; and for I and OU the resonator is in unison. If this is not so, then the quality of the vowel is much altered. Thus if the syren gives A, and the plate used is that for OU, then the sound is A modified. This agrees with the experience of teachers of singing, who hold that a badly sung vowel is a vowel-sound emitted into a cavity adjusted for another vowel. Marage has also found that when the sounds of his syren, aided by the masks, are examined by the manometric method, the flame pictures appear as they may be expected to do, that is, groups of three flames for A, of two for E, EU, and O, and of one for I, U and OU. Vowels then, according to him, are due to an intermittent aëro-laryngeal vibration, strengthened by the oral cavity and producing OU, O, A, E and I, when it is in unison with the sum of the vibrations; transformed by it, and giving origin to other vowels, when there is no unison; and the number of intermittences gives the fundamental note on which the vowel is emitted. If the oral cavity acts alone, the vowel is whispered; if the larynx acts alone, the vowel is sung; and if the two act the vowel is spoken. Marage has applied his method with much success in testing the ear and in the treatment of mutes who are not absolutely deaf. His memoir is characterised by great simplicity and at the same time by thoroughness.

But the study of vowels is not the only result of recent research in phonetics. The analysis of consonantal sounds is now being carried out by various workers, such as Pipping, Scripture and Lloyd. Meyer, in Hermann's laboratory, has investigated the pitch of words, sentences and syllables in speech. This has also been studied by phonographic tracings by Marichelle. The whole subject has also a practical bearing, as the knowledge acquired enables the teacher of deaf mutes so to instruct his pupils in the use of their organs as to avoid the dreary monotone of those who learn to speak by watching only the movements of the lips.

It only remains to notice the remarkable monograph of Jespersen. This is an attempt to aid the study of phonetics by the use of a scientific nomenclature to express sounds, so that just as the chemist represents by letters and figures the nature of a chemical substance of complex constitution, so the student of phonetics may be able to express the sounds of words by symbols. The visible-speech system of Melville-Bell consisted of symbols which expressed more or less accurately the physiological movements to be made, or the position to be assumed, during the pronunciation of a given sound; but the symbols of Jespersen are letters and figures. The letters or figures, however, to be useful must have a physiological meaning. Strictly speaking the symbols denote, not sounds, but the elements of sounds. Thus so simple a sound as *m* is physiologically the result of (*a*) lips shut; (*b*) point of tongue resting in the bottom of the mouth; (*c*) surface of tongue not raised towards the palate; (*d*) nasal passage open; (*e*) vocal cords vibrate; and (*f*) air expelled from lungs. The attempt of Jespersen may be called an analphabetic system of writing, symbolising, not sounds, but the elements of sounds. At present it is severely technical, but it seems to "provide a means of writing down and describing phonetic minutiæ in a comparatively easy and unambiguous manner." It will do for the phonetician what symbolism does for the mineralogist. It is a kind of algebra for speech sounds.

In advocating the establishment of a photographic museum, to be a visual register of the past, Janssen recently wrote as follows:—"Photography registers the chain of phenomena during time, just as writing registers the thoughts of men during the ages. Photography is to sight what writing is to thought. If there is any difference, it is to the advantage of photography. Writing is subject to conventionalities from which photography is free; writing employs a particular language, while photography speaks the universal language."

But if there is to be a museum of photographs, appealing to the sense of sight, why should we not have a museum of sounds, in the shape of phonograph records, appealing to the sense of hearing? How little can we tell from written characters the exact sounds of ancient Sanskrit, or how Demosthenes spoke in Greek or Cicero in Latin? Would it not now be interesting to hear the exact accent of old English, or the Scotch of the fifteenth century? All dialects should be carefully registered and put aside for future consultation, and thus we would do for the ear what we do for the eye. No doubt such a collection of phonographic records would help onwards the science of language.

THE ANCIENT GLACIERS OF SKYE.

IN the central portion of Skye there is a group of mountains unequalled elsewhere in Britain for rugged grandeur. To the south and south-west lie the Cuillin Hills, the serrated peaks of which rise to an elevation of more than 3000 feet; they are built essentially of a great laccolitic mass of gabbro, traversed by countless dykes and sheets of basalt. To the north lie the Red Hills, the smoother outlines and often ruddy aspect of which contrast markedly with the dark and rough elevations of Blath-bheinn, or Blaven, and the Cuillins; they are composed of granite and granophyre, and rise to heights rarely exceeding 2500 feet.

That the whole of this mountain district has been severely glaciated has for many years been recognised, but the detailed history of the ice-erosion has not hitherto been worked out. Mr. Alfred Harker, in the course of a special survey of the region, has had opportunities of study which have enabled him to write an essay on the subject which for completeness and lucidity is probably unsurpassed.[1] The district, as he points out, is one which had for long been subject to erosion; the drainage system in pre-Glacial times was a fully matured one, and the features then stood out in bold relief. Moreover, the amount of post-Glacial erosion has been so trifling that the effects of ice- and frost-action remain practically without modification by later agencies.

Mr. Harker tells how during the period of maximum glaciation the Skye mountains supported a true ice-cap, under which they were wholly buried, and this ice-cap was sufficiently powerful to withstand and divert northwards and southwards great portions of the ice-sheet from the Scottish mainland. He sees evidence of the movements of the lower layers of ice in the striæ on the rock-surfaces and in the dispersal of boulders; the upper layers not improbably took a course less restricted by the form of the ground. He describes the way in which the ice must have been forced into hollows and openings; its action in grinding down and tearing away rocks, irrespective of their mineralogical composition or structure; and its mode of widening and deepening valleys. Attention is drawn to the formation of cirques or corries, due consideration being given to their aspect and relation to the amount of sunshine. The erosion by ice-action of rock-basins, such as those occupied by Loch Coruisk and other lochs and tarns, is clearly stated and is one of the most effective arguments lately published on the subject.

Mr. Harker's observations lead to the conclusion that the principal glaciation was followed by a later and minor period of ice-action, when glaciers occupied the valleys, and, as would be expected, it is not always possible to discriminate between the work done by the greater and lesser agents. The movement of the later ice was, however, very different on many parts of the lower ground from that during the principal glaciation, a difference due to the withdrawal of the Scottish ice-sheet. To the later glaciation are attributed the perched blocks which occur on the bare slopes of some of the Cuillin valleys. That the higher ridges and summits of the ranges show little or no effects of glaciation is due to the fact that they acted as ice-sheds, and escaped erosion owing to the lack of rock-débris in the ice overlying them.

The mountains, as pointed out by Mr. Harker, are for the most part of bare rock, so also are the higher corries, except where encumbered with screes; while in the lower corries and main valleys the drift is never so thick as to obscure the true form of the ground. Hence the story of the ice-erosion is very plainly engraved on the land, while the author's intimate knowledge of the petrology has enabled him to track the courses of many boulders of peculiar mineral composition with absolute certainty.

[1] "Ice-Erosion in the Cuillin Hills of Skye." By Alfred Harker, M.A., F.G.S. *Trans.* Roy. Soc. Edin., vol. xl. part ii., 1901.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual meeting of the Association of Technical Institutions will be held at the Skinners' Hall, London, on Friday, January 31, 1902. The Right Hon. Sir William Hart Dyke, M.P., will be in the chair, and an address will be delivered by the president-elect, Lord Avebury.

MR. WALTER PALMER, M.P., has offered the University of London the sum of 2000*l.* to provide the apparatus required for the proposed post-graduate courses of lectures in physiology. A committee has been appointed to consider the details of the scheme.

THE system of secondary education in Italy forms the subject of criticism at the hands of Prof. Amati Amato, writing in the Lombardy *Rendiconti*, xxxiv. 17. The author regrets that from 1894 to the present time statistical data are very meagre, and it is desirable that a volume should be annually issued showing the number of schools of different grades and their total attendances. The data available for the period up to 1894 are more detailed, and show a marked increase in schools under clerical control and a decrease in those under lay management, and reasons are given for believing that the tendency continues to be in the same direction.

A DEPUTATION representing a number of University colleges waited on the Chancellor of the Exchequer on Friday last in order to place before him reasons why the annual Government grant to these institutions should be increased. In connection with this subject the facts given on p. 175 of this issue are of interest. The grounds upon which the application was made were summarised as follows:—The grant was originally placed upon the Estimates in the year 1889-90, the total amount being 15,000*l.*, apportioned among eleven colleges. An additional grant of 500*l.* was subsequently made to University College, Dundee. In 1897 the grant was increased to 25,000*l.*, which was distributed among twelve colleges. Since then the work of the University colleges has grown in importance and magnitude. New departments have been created, and probably in all the colleges important additions have been made to the teaching staff, together with a largely increased provision of appliances and equipment. In the year 1892 a Treasury committee reported in favour of a total grant of 30,000*l.* being made to the University colleges, a sum in excess by 5000*l.* of that which is at the present time distributed among them. In 1897 new colleges at Reading and Exeter were inspected by a Treasury committee appointed to visit University colleges, and declared at that time not to have reached such a standard in University work as to justify a claim upon a share in the grant. These colleges, together with another, have been again visited by a similar committee, and if by this time they are reported to have reached a standard which justifies their claim to be treated as fully equipped colleges in arts and science some decrease in the grants to other colleges would have to be made unless the total of 25,000*l.* is increased. Replying to the deputation, the Chancellor of the Exchequer said that there was no liability on the part of the Exchequer for University education in England, and declared that this was a doctrine which had always been accepted by Governments and by Parliament. The grant made in 1892 was a purely temporary measure, and did not imply any assumption of liability on the part of the Exchequer. It was only to be regarded as an attempt to aid local effort in places in which there was a strong desire for University education. The experience of the last five years had shown that the grant had had the effect of stimulating local effort. He would carefully consider the whole question; but, while he must decline to pledge himself to any increase of the present grant, he would do his best to prevent any loss falling on the colleges which were now in receipt of it by the admission of new colleges to its benefits.

SCIENTIFIC SERIAL.

American Journal of Science, December.—The geology of the Little Colorado Valley, by Lester F. Ward. The paper is accompanied by a section showing 3500 feet of Trias, of which 1200 are Painted Desert beds, 1600 Shinarump beds, and 700 Moencopie beds.—On pyrite and marcasite, by H. N. Stokes. It is pointed out that although there is no difficulty in distinguishing these two minerals in well-crystallised specimens, there remains a residuum consisting of massive or finely grained material in which this is not possible. The methods which have been proposed for such cases are criticised and found to be insufficient. A method has therefore been developed in which advantage is taken of the difference between the two sulphides in their behaviour towards solutions of ferric ammonia alum, and it has been found possible to apply this to determine the amount of each in mixtures. The application of this process to various samples of doubtful nature, especially of concretions, has shown that the finely fibrous specimens usually passing as marcasite are very commonly pyrite.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman.—The dielectric constant of paraffin, W. G. Wormwell. Four samples of commercial paraffin were examined with a modified form of the Blondlot oscillator, the refractive index for the D line of the samples being also determined. The dielectric constant of a given paraffin increases with the density of the paraffin. It augments rapidly from a temperature 20° above the melting-point to a temperature 30° below the melting-point, and among different paraffins the dielectric constant increases with a rise in the melting-point. A comparison of the results for short electrical waves and short light waves shows that Cauchy's formula as a means of obtaining the index of refraction for indefinitely long waves does not meet the experimental data.—On some new mineral occurrences in Canada, by G. C. Hoffman.—The estimation of molybdic acid reduced by hydriodic acid, by F. A. Gooch and O. S. Pulman, jun. The conditions under which molybdic acid may be accurately determined by reduction with potassium iodide and hydrochloric acid are here laid down, and test analyses showing the accuracy of the method are cited.—The Veramin meteorite, by H. A. Ward. The meteorite consisted of an intimate mixture of metal and mineral, in roughly equal proportions. Analysis of the metallic portion is given.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 5.—"Notes on Quantitative Spectra of Beryllium." By Prof. W. N. Hartley, D.Sc., F.R.S.

In a quantitative examination made in 1885 of all the known methods of separating beryllium from aluminium and from iron the various precipitates obtained were dissolved and diluted to a known volume corresponding with the amount of bases in solution.

The solutions were spectrographically examined, and the photographs compared with others taken from solutions containing accurately weighed quantities of pure beryllia. Wave-lengths of lines shown by solutions containing 0·000001 per cent. of beryllium: 3322·3 extinct, 3130·3 nearly one-half the line still strong, 2649·8 reduced to a dot, 2493·6 a dot scarcely visible, 2478·1 a very fine short line.

The actual length of the line 2478·1, as rendered by solutions of 0·00001 per cent. and 0·000001 per cent. strength, is, in the former, 0·07, and, in the latter, 0·05 of an inch. The normal length of the line at this part of the spectrum is 0·22 of an inch. The quantity of substance yielding this spectrum is equivalent to one-millionth of a milligramme of beryllium. The coefficient of extinction of the two lines λλ3130·3 and 2478·1 had not been reached by the dilution specified.

Beryllia has been separated from the alumina contained in felspar obtained from a granite found in co. Wicklow. From numerous experiments on the analytical processes employed in the separation of beryllia from alumina it was found that it remained combined with the sesquioxide bases in so persistent a manner as to lead to the belief that ordinary alumina might be found more often than not to contain traces of beryllia. Such, however, is not the case, though gallium has been ascertained to be present in almost all minerals which contain aluminium. As they belong to the same group, the two elements aluminium and gallium may be expected to form isomorphous mixtures, which would account for their being so constantly associated in nature; but the position of beryllium in the periodic system of classification shows that a similar behaviour with that element is scarcely probable.

Geological Society, December 4.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On a new genus belonging to the Leperditiadæ, from the Cambrian Shales of Malvern, by Prof. T. T. Groom. Forms referred to Beyrichia have long been known from the Cambrian beds of Scandinavia, Stockingford and South Wales, and the writer has obtained from the

lowest part of the Malvern black shales a species identical with the Stockingford form, which had been provisionally identified with the Swedish *Beyrichia Angelini*. The characters of these specimens serve to separate the species from those now placed under the genus Beyrichia, a conclusion in which Prof. T. Rupert Jones concurs.—The sequence of the Cambrian and associated beds of the Malvern Hills, by Prof. T. T. Groom, with an appendix on the Brachiopoda by Mr. C. A. Matley. The series, exclusive of some 600 feet of igneous rocks, may be estimated at between 2500 and 3000 feet, and consists of the following members, tabulated in descending order:—(4) The bronsil shales, 1000 feet thick; grey shales containing Dictyonema and many Tremadoc brachiopods and trilobites. (3) The white-leaved oak shales; black shales, including: (*b*) The zone of *Peltura scarabaeoides*, *Sphaerophthalmus alatus*, *Ctenopyge pecten*, *Ct. bisulcata* and *Agnostus trisectus*; 500 feet. (*a*) The zone containing *Kutorgina pusilla*, *Protospongia fenestrata*, a new variety of Acrotreta, and a new genus of the Leperditiadæ; 30 feet. (2) The hollybush sandstone, comprising: (*b*) Massive sandstone probably not less than 1000 feet thick, and containing *Kutorgina Phillipsi*, *Orthotheca fistula*, *Scolecoderma antiquissima*, and new species of Hyolithus. (*a*) Flaggy and shaly beds, not less than 75 feet thick; chiefly flaggy and shaly glauconitic sandstones, with *Kutorgina Phillipsi*, *Scolecoderma antiquissima*, *Hyolithus*, &c. (1) The Malvern quartzite, consisting chiefly of grey quartzites and conglomerates, rarely glauconitic; probably at least several hundred feet thick; containing *Kutorgina Phillipsi*, *Hyolithus primaevus* and a new species of Obolella. Three new species of Hyolithus are named and described in full, and four in outline, while a revision of Holl's species *H. fistula* is given. Notes are also given, by Mr. Philip Lake and the author, on *Agnostus trisectus*, *Cheirurus Frederici* and other trilobites, and a name is given to certain cylindrical bodies which appear to be the eggs or excreta of some animal.

Entomological Society, December 6.—The Rev. Canon Fowler, president, in the chair.—Mr. J. H. Carpenter exhibited a number of *Colias hyale* bred from ova laid by the parent butterfly taken at Sheerness, August 18, 1900. Twelve months ago there was no trustworthy evidence as to how *C. hyale* passed the winter, but Mr. Carpenter discovered that it hibernates in the larval state and pupates and emerges in the spring. No one has yet successfully bred *C. edusa* through the winter, as they do not, and cannot, feed up these in this country. *Hyale*, on the other hand, is perfectly quiescent during the winter months, and nothing would induce the larvæ to feed at that period even when subjected to a temperature of between 60° and 70° F.—Mr. R. S. Standen exhibited specimens of *Lycaena dolus*, the type, from Bordighera, and also *Pieris brassicae* with greenish underwings, a common form in the neighbourhood of Florence.—Mr. C. P. Pickett exhibited pupa-cases of *Saturnia pavonia*, one with two openings, one with no openings, and a third containing three pupæ, from one only of which the imago had emerged. Mr. J. W. Tutt said that this phenomenon was not unusual in the case of silkworms, and commonly occurred also in the case of artificially bred *Lasiocampa lanestris*, being probably due to overcrowding.—The Rev. A. E. Eaton exhibited specimens of *Psychodidae* of morphological interest, preserved in corked tubes.—Mr. H. St. J. Donisthorpe read a paper entitled "The Life-History of Clythra 4-punctata," and Mr. G. Kirkaldy communicated "A Memoir upon the Rhynchotal Family Capsidæ."

Royal Meteorological Society, December 18.—Mr. W. H. Dines, president, in the chair.—The Hon. Rollo Russell read a paper entitled "Further Observations and Conclusions in relation to Atmospheric Transparency." For a number of years past he had made daily observations on the clearness of the atmosphere at Haslemere, Surrey, and in the paper he gave the results of the same. The principal conclusions derived from these observations are:—Haze and fog are commonly caused by the mixture of currents at different temperatures. These currents may be local or general, high or low. Thick haze or fog not dependent on different currents is rare, but differing currents frequently come into contact without producing haze or fog, and fairly clear weather under opposite currents is not uncommon. A fog may generally be taken *ipso facto* as evidence of the existence in the neighbourhood of a conflict of currents, and prevalent fog or haze commonly signifies that a different wind exists at a high level from that on the surface or at a slight elevation. The production of fog or haze by mixing currents depends chiefly on differences in their temperature. Broadly-extended westerly winds, with westerly upper currents, are the clearest, and visibility may reach the highest figures during their prevalence, whether they are dry or nearly saturated. Easterly and north winds are the most hazy, owing to the ordinary upper current from the west being seldom displaced by them, and to the mixture of these masses of air of different temperatures. When, as an exception, east and north winds are clear, it may be presumed, without direct evidence, that the upper current coincides with them in direction. In winter, therefore, unusual clearness in these winds often signifies a long spell of frost.—The other papers read were: Remarkable phosphorescent phenomenon observed in the Persian Gulf, April 4 and 9, 1901, by Mr. W. S. Hoseason; and the mechanical principle of atmospheric circulation, by Capt. R. A. Edwin, R.N.

Mathematical Society, December 12.—Major MacMahon, R.A., F.R.S., in the chair.—Prof. Love, F.R.S. (hon. sec.) communicated a paper by Mr. J. H. Michell on the flexure of a circular plate. Prof. Lamb, F.R.S., also spoke on the subject of the paper.—Lieut.-Col. Cunningham, R.E., gave a short sketch of Euler's method of finding "amicable" numbers and announced the discovery of two new primes A, B; where $A = f.a$, $B = f.b.b^1$. Then, in one pair, (A, B) $f = 3^4.7.11^2.19$; in the other pair (A, B) $f = 3^5.7^2.13.19$. In both pairs $a = 8747$, $b.b^1 = 53 \cdot 161$.

CAMBRIDGE.

Philosophical Society, November 25.—Dr. J. Larmor, vice-president, in the chair.—The negative radiation from hot platinum, by Mr. O. W. Richardson. The radiation was investigated experimentally chiefly by measuring its variation with the temperature of the metal. The radiating surface was that of a fine platinum wire heated by a steady current. The saturation current from the wire to a surrounding cylinder was measured by means of a sensitive Thomson galvanometer through which the cylinder was put to earth. The pressure in the apparatus varied from ·008 to ·16 mm. The temperature of the wire was obtained by determining its resistance. It was shown that there was no sensible current when the wire was charged positively; with a negative charge on the wire the current rose to as much as 4×10^{-4} amperes at 1600° C. The results are shown to be consistent with the theory that the effect is due to corpuscles escaping from the metal.—On the ions produced by an incandescent platinum, by Prof. J. J. Thomson. The incandescent metal in these experiments was at a temperature between a dull red and a bright yellow heat. At these temperatures only positive ions are produced in the neighbourhood of the wire. Curves showing the relation between the current and the potential difference were obtained; these curves show three well-marked stages. In the first stage the current increases more rapidly than the potential difference. In the second stage the rate of increase of the current diminishes rapidly, the current becoming towards the end of the stage independent of the difference of potential; this at low pressures is followed by a third stage in which the current again increases rapidly, indicating the formation of fresh ions. The currents when the potential difference was increasing differed frequently from those for the corresponding potential when decreasing—the curves often indicating a kind of hysteresis. The saturation current between a hot and a cold platinum plate was found to be independent of the distance between the plates. The masses of the positive ions were determined by the method previously used by the author to determine the masses of the negative ions arising from ultra-violet light or metals at a white heat; it was found that the carriers of electricity were not all of the same kind; the mass of the smallest of these had a mass of the same order as that of a molecule of oxygen.—On the action of incandescent metals in producing electric conductivity in gases, by Mr. J. A. McClelland.—On the seminvariants of systems of binary quantics, the order of each quantic being infinite, by Major P. A. MacMahon.—On the zeros of polynomials, by Mr. J. H. Grace.—The type-specimens of *Lyginodendron oldhamium*, Binney, by E. A. N. Arber.

EDINBURGH.

Royal Society, December 2.—Lord Kelvin, president, in the chair.—The president read an obituary notice of Prof. Tait, which contained interesting reminiscences of their work together when they were preparing "Thomson and Tait."—Dr. Halm, in the second part of his paper, on the state of equilibrium of

stellar atmospheres, gave further illustrations, from the conditions holding in our own atmosphere, of the distinction between thermostatic equilibrium and convective equilibrium, the former being characteristic of the upper strata and the latter of the lower strata, especially in the neighbourhood of mountains. Passing to the case of the sun, he found it necessary to assume (in order to explain the *height* of the chromosphere) that hydrogen gas contains an appreciable amount of potential energy, latent heat, as it were, stored up by the dissociation of its molecules into smaller molecular groups. A comparison of the deviations from Dulong and Petit's well-known law led to a division of the elements into two groups, of which iron and carbon might be taken as the types. In the one group the molecular potential energy increases with the temperature, in the other it diminishes. Hydrogen belongs to the former group. These considerations also gave a clue to the comparative smallness of the layer of metallic vapours in the sun, and, moreover, explained why the spectra of the hottest stars were characterised by a broadening of the hydrogen lines and a narrowing of the lines of the metallic vapours. Finally, it was shown how a change of temperature in part of the sun's photosphere would, on the principles developed in the paper, at once cause violent outbursts of hydrogen gas, such as are observed in the solar protuberances.—Lord Kelvin exhibited a model of the diatomic equilateral crystalline assemblage described in his paper on molecular constitution of matter, Roy. Soc. Edin., July, 1889. By means of this model any relation between the rigidity and the resistance to compression could be obtained, thereby completely disposing of the reasoning of the older French elasticians, who believed that there must be a definite relation between the two elastic constants in an isotropic elastic solid.

DUBLIN.

Royal Irish Academy, December 9.—Prof. R. Atkinson, president, in the chair.—Prof. J. P. O'Reilly read a paper on the waste of the coast of Ireland. In this paper the author discussed the different stages of change that the country had gone through following the work of Prof. Boyd Dawkins, "Early Man in Britain and his Place in the Tertiary Period." Taking the state of the country at the end of the Pleistocene period, when the great forests covered the surface of the upraised drift surface, he pointed out how this has been taken to indicate the then existence of land extending off to the west either as a continental plateau or as a series of islands which sheltered this forest growth, now impossible owing to the harsh winds which come in directly from the ocean. He directed attention to the report of Messrs. Newton and Teall, referred to in NATURE, vol. lvii. p. 324, on the lava sheets of Franz Josef Land, which tends to admit the former existence of an immense basaltic plateau of which the islands Spitsbergen, Jan Mayen, Iceland, Greenland, the Faroes, Hebrides and N. Ireland formed part, the subsequent break-up of this plateau giving rise to islands and to the present state of those mentioned. Explaining how meagre the details are concerning the changes undergone by the coast of Ireland in past times, he pointed out how these might be supplemented by examining what the coasts of the northern islands, Scotland, Cornwall and of France had suffered in loss from the continual beat and wear of the Atlantic storms and waves. The loss and waste he showed to be far greater than is generally imagined, and that Ireland and the islands which once bordered it to the west, south-west and north-west must have undergone, and be actually suffering, very great and serious waste and change. Considering the great scientific importance of the question, it was submitted that it would be becoming on the part of the Royal Irish Academy to promote a survey of the coast line as it actually stands at this commencement of the twentieth century, and to have points fixed as has been done for the coast of Scandinavia, so that hereafter it may be possible accurately to fix the rate at which the island is being wasted away by the Atlantic waves, and in this manner to allow of a determination being made of what was its former extent in prehistoric and early historic times.—Prof. Charles J. Joly read a paper on the point representations of screws. The reciprocal of the quadric in six variables representing screws of a given pitch plus p, taken with respect to the quadric of zero pitch, is shown to be the quadric of pitch minus p. From this property the remarkable relations detailed by Sir Robert Ball in his recent memoir, "Further Developments of the Geometrical Theory of Six Screws," are easily deducible. In the second part of the paper a method is explained of representing a screw by a pair of weighted points in a given plane—the five numbers required consisting of the ratio of the weights and the two coordinates of each point of the pair.

NEW SOUTH WALES.

Royal Society, October 3.—Prof. Liversidge, F.R.S., president, in the chair.—Marriage and descent among the Australian aborigines, by R. H. Mathews. In this short paper the author dealt with the social laws of some tribes in New South Wales, Queensland and elsewhere. Tables and genealogies were supplied illustrating the marriage restrictions, and the descent of the resulting progeny. A brief description was given of certain inaugural ceremonies through which the youths have to graduate in order to reach the status of aboriginal manhood.—On the constituent of peppermint odour occurring in many Eucalyptus oils—part i., by Henry G. Smith. The first Eucalyptus oil was distilled by Dr. White in 1788, at Sydney, and owing to the great resemblance between this oil and that obtained from the peppermint *Mentha piperita*, he named the tree from which he had obtained the oil the "Peppermint Tree." Its botanical name is *Eucalyptus piperita*. Since then many other species of Eucalyptus have been found to have this peppermint odour, and are generally known as "peppermints." The constituent giving this odour has now been isolated. It occurs in greatest amount in the oil obtained from the leaves of *E. dives*, next in that of *E. radiata*, and in fair amount in the oils of several other species. It is usually found in those Eucalyptus oils in which the principal terpene is phellandrene, although this is not always so, but generally there is an almost entire absence of Eucalyptol in those oils in which it occurs most abundantly. The crude oil of *E. dives* was taken for the preparation of this peppermint constituent. This constituent is not menthone, and is probably a new ketone; a molecular determination gave 155, so that probably its formula may eventually be found to be $C_{10}H_{18}O$.—On the crystalline structure of gold nuggets from Klondyke, Victoria and New Zealand, by Prof. Liversidge, F.R.S. Sections of three nuggets from Klondyke were shown. The crystal faces are comparatively small, and the nuggets have a granular structure, as if built up of separate grains, of one or two millimetres in diameter. They are also more fissured and contain more cavities than usual. The sections of Victorian (Australian) and New Zealand nuggets are also made up of small crystals, and they present numerous small cavities after the removal of the quartz and iron oxide by treatment with hydrofluoric and hydrochloric acids, so that the sections present quite a different appearance from the very compact and largely crystallised nuggets from West Australia.

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