THURSDAY, MAY 11, 1899.

THE NATIONAL PHYSICAL LABORATORY.

THE following Scheme for the government of the National Physical Laboratory has been drawn up by the Royal Society with the approval of Her Majesty's Treasury, and steps are being taken to give effect to the Scheme at as early a date as practicable. The Government has promised to ask Parliament for a grant of 12,000*l.* for buildings, and an annual grant of 4000*l.*, and will also facilitate the erection of the buildings in the Deer Park at Kew. The resources of the Kew Committee of the Royal Society and the buildings used by them will also be handed over to the new Institution.

The grant will not be available until voted by Parliament, and the first grant will be 5000*l.* for buildings and 2000*l.* in respect of the first half-year. The Treasury have, however, approved of the immediate nomination of the new governing body, and have authorised any preparations for the work of the Laboratory, which can be undertaken without expenditure, previous to the sanctioning of the anticipated grants by Parliament.

The President and Council of the Royal Society have accordingly appointed the Executive Committee, in accordance with the provisions of the Scheme, with a view to preliminary arrangements being set on foot as soon as possible; and will shortly proceed to complete the constitution of the General Board. The representatives nominated by the technical Institutions named in the Scheme to serve on the General Board are as follows:—

Mr. W. H. Preece, F.R.S. ... ... Sir J. Wolfe-Barry, F.R.S.	Institution of Civil Engineers.
Sir Wm. White, F.R.S. ... ... Sir Edw. Carbutt, Bart.	Institution of Mechanical Engineers.
Mr. Alex. Siemens ... ... Prof. Ayrton, F.R.S.	Institution of Electrical Engineers.
Sir Wm. Roberts-Austen, F.R.S. Sir Fredk. Abel, F.R.S.	Iron and Steel Institute.
Mr. Geo. Beilby ... ... Mr. Walter F. Reid	Society of Chemical Industry.
Sir Nathaniel Barnaby ... ... Mr. J. T. Milton	Institution of Naval Architects.

The President and Council of the Royal Society have appointed as Vice-Chairman of the General Board and of the Executive Committee:

Lord Rayleigh, F.R.S.

The following are the other members of the Executive Committee:

Lord Lister, President of the Royal Society. Mr. A. B. Kempe, Treasurer of the Royal Society. Prof. A. W. Rücker, as Secretary of the Royal Society. Sir Courtenay Boyle, K.C.B., Permanent Secretary of the Board of Trade.	*ex officio.*
Capt. W. de W. Abney, F.R.S. ... ... Capt. E. W. Creak, F.R.S. ... ... Prof. G. Carey Foster, F.R.S. ... ... Mr. F. Galton, F.R.S. ... ... Prof. J. Perry, F.R.S. ... ... Gen. Sir R. Strachey, F.R.S.	from among the Members of the Kew Observatory Committee.
Sir John Wolfe-Barry, F.R.S. ... ... Sir Edward Carbutt, Bart. ... ... Mr. Alex. Siemens ... ... Sir William Roberts-Austen, F.R.S. ... Mr. G. Beilby ... ... Sir Nathaniel Barnaby	from among those Members of the General Board nominated by the technical Societies named in the Scheme; and
Prof. R. B. Clifton, F.R.S. ... ... Prof. O. Lodge, F.R.S. ... ... Sir Andrew Noble, F.R.S. ... ... Prof. A. Schuster, F.R.S. ... ... Prof. J. J. Thomson, F.R.S. ... ... Dr. Thorpe, F.R.S.	Nominated by the President and Council of the Royal Society.

The Scheme of Organisation of the Laboratory is as follows:—

1. The name of the Institution shall be the National Physical Laboratory. The Kew Observatory shall be incorporated therewith.

2. The ultimate control of the Institution shall be vested in the President and Council of the Royal Society, who, in the exercise thereof, may from time to time issue such directions as they may think fit to the General Board and Executive Committee hereinafter described. The President of the Royal Society shall be the Chairman of the Governing Body as hereinafter defined. The income and all other property of the Institution shall be vested in the Royal Society for the purposes of the Institution.

3. For the present, and until otherwise ordered by the President and Council of the Royal Society, with the approval of H.M. Treasury, there shall be a Governing Body for the Institution, consisting of a General Board and an Executive Committee, the constitution and duties of which shall be as hereinafter defined. Provided always that the Permanent Secretary of H.M. Board of Trade shall be *ex officio* a member of the Governing Body, and that the choice of members of the Governing Body, or of any Committee thereof, shall not be confined to Fellows of the Royal Society.

4. The General Board shall consist of the President, Treasurer, and Secretaries of the Royal Society, the Vice-Chairman of the Board (appointed as defined below by the President and Council of the Royal Society), the Permanent Secretary of the Board of Trade, and of thirty-six ordinary members.

Twenty-four of the ordinary members shall be appointed by the President and Council of the Royal Society; of the remaining twelve ordinary members, two shall be nominated for appointment by the Council of each of the following Institutions, as being fitted to represent commercial interests in connection with the Laboratory:—

The Institution of Civil Engineers.
The Institution of Mechanical Engineers.
The Institution of Electrical Engineers.
The Iron and Steel Institute.
The Institution of Naval Architects.
The Society of Chemical Industry.

In the selection of ordinary members of the General Board care shall be taken that Scotland and Ireland are represented.

Any person not being already a member of the General Board who shall become a member of the Executive Committee, shall be a member of that Board during his tenure of office on the Executive Committee, but shall be regarded as an additional, and not as an ordinary member of the Board.

5. The Executive Committee shall consist of the President, Treasurer, and one of the Secretaries of the Royal Society; the Vice-Chairman of the Executive Committee (appointed as defined below); the Permanent Secretary of the Board of Trade; six persons appointed by the President and Council of the Royal Society from among those who are members of the Kew Observatory Committee at the time when the Kew Observatory is incorporated in the National Physical Laboratory (two of these six persons shall retire at the end of every two years, and vacancies occurring amongst them by retirement or otherwise shall not be filled up); and of twelve ordinary members.

The ordinary members shall be nominated by the

President and Council of the Royal Society, but one-half shall be chosen from among those members of the General Board who have been nominated as fitted to represent commercial interests on that Board.

Those members of the Executive Committee who are Fellows of the Royal Society, shall be appointed by the President and Council to be the Gassiot Committee of the Royal Society.

6. The Vice-Chairman of the General Board shall be appointed by the President and Council of the Royal Society, and shall also be Vice-Chairman of the Executive Committee. He shall hold office for six years, and shall be eligible for reappointment, but shall not hold office for more than twelve years.

7. At least one-sixth of the ordinary members of the General Board and of the Executive Committee shall retire annually.

In the case of the General Board, the retiring ordinary members shall be those who have not attended a meeting of the Board for two years, together with so many other members of the Board, selected by seniority, as may be necessary to bring the number of retiring members up to one-sixth of the whole number of ordinary members of the Board.

In the case of the Executive Committee, the retiring ordinary members shall be those who have not attended one-half of the meetings of the Committee during the previous year, together with so many other members of the Board, selected by seniority, as may be necessary to bring the number of retiring members up to one-sixth of the whole number of ordinary members of the Board.

No retiring member of the General Board or of the Executive Committee shall be eligible for reappointment until at least one year has elapsed from the date of his retirement.

The President and Council shall have power to remove from the General Board and from the Executive Committee any member of either whom they may judge to be disqualified.

Vacancies on the General Board or on the Executive Committee due to death, resignation, or removal by the President and Council of the Royal Society, shall be filled by the President and Council of the Royal Society, provided always that—

(1) Any person so appointed shall, for the purposes of the regulations for retirement from the Board or Committee, be regarded at the time of his appointment as having served for the same period as the member to whose place he succeeds.

(2) If the vacancy on the General Board be caused by one of the persons nominated as fitted to represent commercial interests ceasing to be a member of the Board, the President and Council of the Royal Society shall choose his successor from among a list of names recommended by the Councils of the Institutions named in Section 4.

(3) If a vacancy on the Executive Committee be caused by one of the persons nominated as fitted to represent commercial interests ceasing to be a member of the Committee, his successor shall either be selected from among those members of the General Board who were nominated as fitted to represent commercial interests, or shall be nominated by the President and Council of the Royal Society after consultation with the Councils of the Institutions named in Section 4.

The President and Council of the Royal Society shall determine the order of the seniority of the members of the first General Board and of the first Executive Committee for the purposes of the regulations for retirement.

The Executive Committee.

8. The Executive Committee shall have the immediate management of the National Physical Laboratory; shall appoint and dismiss the officials, except the Director; and shall determine the nature of the work to be undertaken from time to time.

The General Board.

9. A meeting of the General Board shall be held in October, at which the Executive Committee shall present a report on the work and finances of the National Physical Laboratory during the year ending on the preceding September 30. Copies of this report shall be circulated among the Members of the General Board at least one week before the meeting, and after the meeting shall be forwarded to the President and Council of the Royal Society, together with any further report, resolutions, or recommendations which may be added by the General Board.

The Executive Committee shall also lay before the General Board at its meeting in October a statement as to the work which it is proposed to undertake in the Laboratory during the ensuing year. This statement shall be circulated among members of the Board at least a week before the meeting; and the General Board may make such recommendations relative to the statement, or to the future work of the National Physical Laboratory, as they may think fit.

These recommendations shall be laid before the Executive Committee for their consideration.

Sub-Committees.

10. The Executive Committee may from time to time appoint Sub-Committees, of which the members shall not necessarily be members of the Executive Committee or of the General Board, either to superintend or to assist in certain specified investigations, or to superintend some department of the National Physical Laboratory.

The Director.

11. The Director of the National Physical Laboratory shall be appointed by the President and Council of the Royal Society after consultation with the Executive Committee, on such terms as the President and Council may determine, and shall be removable by the President and Council. He shall be responsible to, and shall take instructions from, the Executive Committee, but, subject to such instructions, he shall have the sole direction and control of the officials of the National Physical Laboratory and of the work done within it.

The Executive Committee may delegate its power of appointing and dismissing the officials of the Institution to the Director in such cases as it may think fit.

The Director shall neither be allowed nor be called upon to undertake work not connected with the National Physical Laboratory, except with the consent of the Executive Committee.

Finance.

The Royal Society shall open a banking account, to be called "The National Physical Laboratory Account of the Royal Society," into which all sums received by the Executive Committee for the purposes of the Institution shall be paid. The Treasurer of the Royal Society shall also pay into this account all sums received by him for the said purposes, after deducting therefrom such amounts as he shall be directed by the President and Council, with the approval of the Treasury, to retain for the purpose of defraying any expenses which the Royal Society may incur in the exercise of its control of the Institution.

The Executive Committee shall be empowered to draw on this account for the purposes of the Institution by cheques signed by such members of the Executive Committee as may be authorised by the Committee to do so.

Legal Proceedings.

Any legal proceedings with regard to the affairs of the Institution, which it may become necessary to institute or defend, shall be instituted or defended by the Solicitors of the Royal Society, in the name and on behalf of the Royal Society upon the instructions of the Executive Committee, but no such proceedings shall be instituted or defended without the order of the President and Council of the Royal Society.

The Kew Observatory Committee of the Royal Society.

"The Kew Observatory Committee of the Royal Society," incorporated under the Companies Act, 1867, shall be wound up; and the property thereof shall be held by the Royal Society for the purposes of the Institution.

CHEMICAL TECHNOLOGY.

Outlines of Industrial Chemistry. A Text-book for Students. By Frank Hall Thorp, Ph.D., Instructor in Industrial Chemistry in the Massachusetts Institute of Technology. Pp. xx + 541. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1898.)

IN writing a book such as the present, the author's main difficulty must be in deciding what to omit. The number of industries in which chemistry plays a more or less important part is so large, and their nature so varied, that it would appear to be almost impossible to give even a moderately satisfactory account of them within the limits of one volume. By omitting metallurgy altogether, and condensing the preparation of the artificial organic dye-stuffs into a little over eight pages, the author succeeds in finding space for the essentials of the majority of the remaining chemical industries. The omission of metallurgy is justified by the facts that this subject is usually taught independently, and that several good short text-books dealing with it already exist. The hemistry of the artificial organic colouring matters is generally included in courses of lectures on organic chemistry, and, presumably for similar reasons, no mention is made of the majority of the pharmaceutical and photographic chemicals.

An introductory section contains a general account of the apparatus employed in performing such common operations as evaporation, filtration, distillation, calcining, and so on, on the large scale. The diagrammatic sketches employed in this section, and throughout the book, are very clear and are calculated to be of much more service to a student than elaborate illustrations of the outside of the apparatus or even complicated working drawings would be. The two cuts on pp. 12 and 13, representing filter-presses, might with advantage have been replaced by diagrams.

After a brief account of the main facts about fuels and water, the different chemical industries are considered, about equal space being devoted to those dealing with norganic and those dealing with organic substances. The accounts of the origin and properties of the raw materials, and of the different operations and transformations through which they pass on their way to the finished products, are clear and concise; in most cases the author has succeeded admirably in subordinating mere detail whilst bringing out clearly the essential factors on which the success of the process depends.

The treatment of some of the more recent developments of technical chemistry is not quite so satisfactory as that accorded to the older industries; the account of the electrolytic processes for the preparation of alkalis and chlorine being perhaps the least satisfactory chapter in the book. The author of a work on industrial chemistry is, of course, hampered to some extent by the natural and inevitable reticence of the inventors of new processes; but, even allowing for this, the chapter might have been improved by a wider acquaintance with the recent literature of the subject. This, in passing, is true, though to a less extent, of the chapter dealing with the cyanide industry in which so much progress has been made of late years.

In speaking of the Deacon chlorine process, on p. 99, the author remarks that since the reaction between hydrochloric acid and oxygen evolves heat, the temperature of the tower in which the reaction occurs should "theoretically" be maintained without further heating, but that this is not the case. In reality, of course, the whole thing depends on the relation between the amount of heat evolved by the chemical change and that lost by radiation, convection, and conduction. He goes on to say:—

"Theoretically, too, all the chlorine of the hydrochloric acid should be recovered, but practically the reaction is far from complete."

Since it is well known that the reaction

$$2HCl + O = H_2O + 2Cl$$

is reversible, an equilibrium must tend to be established; this equilibrium will not be displaced by the presence of a catalytic agent (which merely accelerates the velocity with which the equilibrium is approached), so that the practical result is only in disaccord with the incorrect theory.

These are, however, but minor blemishes in a book which attains a very high average of excellence. We are not acquainted with any other book in English which covers the same ground, and there is no doubt that it will prove to be of great service to all persons interested in technical chemistry, and more especially to the students and teachers to whom it most directly appeals. T. E.

VOLCANOES.

Volcanoes: their Structure and Significance. By T. G. Bonney, D.Sc., LL.D., F.R.S., Professor of Geology at University College, London. Pp. 337. With 12 Plates, a Map, and 21 Illustrations in the Text. "The Progressive Science Series." (London: John Murray. New York: G. P. Putnam's Sons, 1899.)

IN this work the author has succeeded in giving, within convenient limits, a clear and very readable account of the present state of vulcanological science. The work is not burdened with scientific details nor made unattractive by a too technical terminology; but it nevertheless contains a trustworthy discussion of the most recent researches of geologists, and their latest views upon questions connected with these very interesting natural phenomena.

The first chapter, entitled "The life-history of volcanoes," contains succinct descriptions of a number of celebrated volcanic outbursts, including that of Vesuvius in A.D. 79, and later eruptions, of Monte Nuovo in 1538, of Stromboli, Bandai-san in Japan, Galoongoon in Java, Krakatoa, Kilauea in the Sandwich Islands, Skaptar Jökull in Iceland, Cotopaxi, Graham Island, and Bogosloff in Behring's Sea; lastly, of the mud volcanoes of Baku, and of Krabla in Iceland, and the geysers of the Yellowstone Park. These examples are admirably chosen to illustrate the varied manifestations, and successive phases of volcanic activity, and serve at the outset to give the student a clear idea of the nature and sequence of the phenomena, which it is the object of the work to explain.

The second chapter deals with "The products of volcanoes," and in it the author has evidently experienced some difficulty in maintaining the popular character of the work, while at the same time supplying accurate petrographical information. The explanation of mineral and rock names being relegated to a glossary, a fairly complete sketch is given of the classification and nomenclature of the igneous rocks. The admirable photographs of rock-sections in this part of the work serve to make the descriptions more intelligible.

In the third chapter, on "The dissection of volcanoes," an account is given of the results obtained from the study of volcanic piles in various stages of degradation under the agencies of denudation. Commencing with the "puys" of Auvergne, which Prof. Bonney describes from personal observation, and going on to the Eifel with its crater lakes, the great lakes of Central Italy and Oregon are alluded to, and then the more or less ruined volcanic cones, and crater rings of Santorin, Etna, and other districts are referred to, to illustrate the salient features of volcanic structures; and in the end illustrations are taken from the still more ruined volcanoes of central Scotland and Hungary, and from the structures which have received the name of laccolites in the western territories of the United States, and the midland district of England.

The next chapter is on "The geological history of British volcanoes," and attempts a chronological sketch of volcanic activity in the British Islands. Prof. Bonney in the main adopts the results arrived at on this subject by the officers of the Geological Survey, though he points out that many of their conclusions are not free from doubt. The sixth chapter, which gives a sketch of "The distribution of volcanoes," brings the descriptive portion of the book to a close. In this part of the work, much information has been incorporated which has been obtained by travellers and others during the last twenty years, and since the time at which most of the earlier English treatises on vulcanology have appeared. The general account of volcanoes all over the globe, with the discussion of the main features of their geographical distribution, is as complete and full as could be expected in some eighty pages, and enables the author to marshal a number of facts which are of the greatest service in leading up to the theoretical speculations to which the seventh and last chapter are devoted.

In referring to Prof. Bonney's remarks upon volcanic theories, it is only fair to point out that he himself admits that he is unable to supply "any complete theory of vulcanicity," and that he thinks we must wait for some time before any such theory, which will satisfy all the conditions of the problem, will be found. To use his own words:—

"We are, I think, in this position: We have ascertained a number of important facts; many of these suggest conclusions, but some of the latter seem at present difficult to reconcile and harmonise. Indeed it is my opinion that either some link in the chain of evidence still remains to be discovered, or the relation of those which we know is not yet fully understood. In other words, we do not seem to be in a position to put forward a complete explanation of vulcanicity. Nevertheless, I am sanguine that, to borrow an appropriate phrase from a child's game, 'we are getting warm,' and that our successors, by the end of the first quarter of the coming century, will have got much nearer to the solution of the problem."

In spite of this disclaimer on the author's part of any ability to propound a complete theory of vulcanicity, the concluding chapter of the work may be scanned alike by the general reader and the student of science with much profit. An account is given of numerous speculations upon the various portions of the question of vulcanicity, which have of late years attracted considerable attention, and the author's criticisms and suggestions are well worthy of perusal and consideration.

The volume, which is one of the handsome "Progressive Science Series," is admirably printed and fully illustrated; it constitutes a valuable addition to the popular books of science of the day. J. W. J.

OUR BOOK SHELF.

Recueil de données numeriques publié par la Société française de Physique, Optique. Par H. Dufét. Deuxième Fascicule. Propriétés optiques des Solides. Pp. vi + 367. (Paris: Gauthier-Villars, 1899.)

THE data collected in this volume should prove of value in physical and chemical laboratories. The first section contains the indices of refraction, and their variation with temperature, of calcite, quartz, fluorine, rock-salt, sylvine (potassium chloride), and common alum. The second collection of tables comprises determinations of the refractive indices, at ordinary temperatures and for various wave-lengths, of glasses of known chemical composition. The optical properties of solid inorganic substances are tabulated in the third section, and of organic bodies in the fourth. These two sections occupy the greater part of the volume, and they should be of particular service to mineralogists and chemical crystallographers. Tables on the influence of temperature on the optical properties of solids, and on the indices of some metals and metallic compounds conclude the work.

The Natural Mineral Waters of Harrogate. By F. W. Smith, M.D. Pp. 101. (London: Dawbarn and Ward, 1899.)

DR. SMITH considers the natural waters of Harrogate chemically, therapeutically, and clinically, with reference to their suitability for drinking and bathing purposes. He maintains that the springs of Harrogate compare very favourably with those of Baden-Baden, Homburg and Kissingen, and that there is no need for invalids to run the risk of a journey to the Continent. Full analyses, by trustworthy chemists, are given of all the varieties of mineral waters with which this Yorkshire spa is endowed, and much valuable information concerning the local rainfall, temperature and mortality should cause this well-illustrated volume to take its place as a handy guide for "the doctors of this country," to whom Dr. Smith dedicates his work.

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.*]

A Measure of the Intensity of Hereditary Transmission.

THE possessors of certain hereditary characters are unquestionably *sub-prolific*; that is, they eventually contribute less than their average share to the stock of the future population. It may be that they die before the age of marriage, or that they are sexually unattractive or unattracted, or that if married they are comparatively infertile, or that if married and fertile the children are too weakly to live and become parents. It is very probable, though I have no trustworthy facts to confirm the belief, that persons affected with hereditary insanity are sub-prolific because their families, if they have any, are apt to contain members who are afflicted in various ways that render them less likely than others to live and to marry. But I do not propose to go into the details of this or of any other malady, but merely mention it as an illustration of what is meant, when I assume that the possessors of some particular characteristic, not necessarily a morbid one, and which may be called A, are sub-prolific on the average.

It is a familiar statistical fact that the characteristics of a population, taken as a whole, who live under uniform conditions, change very little during many successive generations. So many per million of them are always found to be affected in this way, so many per million in that. The birth-rate continues the same, so does the death-rate; similarly as regards the various kinds of accident, and also, it may be inferred, as regards each form of disease, though it would be difficult to prove this in all cases, owing to improvements in diagnosis and nomenclature which make the statistics of disease for one period not comparable on strictly equal terms with those of another. It is therefore reasonable to discuss what might occur in an ideal population, which we will call P, whose characteristics are absolutely unchanged during successive generations, and to make such small corrections in the results as the conditions may require when dealing with real populations.

P and A being thus defined, it is obvious that the characteristic A must be transmitted with exceptional intensity in P. The possessors of A leave comparatively few descendants, consequently those few must be over-richly endowed with A; otherwise the number of the possessors of A would steadily diminish, and a P population would be impossible. Wherever a P population occurs, there must exist an inverse relation between the intensity with which A is hereditarily transmitted, and the prolific faculty of those who possess it.

This consideration may be of practical importance to actuaries in enabling them to estimate more justly than at present, the weights to be assigned to different hereditary diseases. It is a most difficult and delicate matter to attack this question directly, namely by making exhaustive inquiries into the life-history of all the near relatives of those who suffer from any serious hereditary malady. The difference in the results arrived at by different inquirers proves this, and shows the need of some second and independent method of investigation. The above considerations supply such a method in all cases where the frequency of the disease is found to have been approximately constant during successive generations of the population taken as a whole.

All that will then be needed, is to find how far those affected by the disease in question have been prolific, testing their capacity in that way by the number of their adult descendants in (say) the *second* generation, those in the first generation indicating little more than their fertility, which, as the children may be weakly, is not the same thing as the capacity of the parents for contributing to the future population. When the descendants in the second generation are neither more nor less numerous than the generality, the intensity of the transmission of the disease would be the same as that of any neutral quality, such as a moderate difference of stature. But if those descendants were more numerous than the generality, the intensity of transmission must be less than the average, while if the descendants were less numerous, the intensity would be greater.

It must be clearly understood that this method is of general application, and is not intended to be confined to morbid characters only. FRANCIS GALTON.

Triboluminescence.

THE interesting list of substances mentioned in to-day's review in NATURE of a paper on the subject of the above phenomenon, mentioning as substances in which it is conspicuous, cane-sugar, saccharin, hippuric acid, and some still more complex organic bodies, might lead one to suppose that only substances of an organic nature, in a crystalline state exhibit the kind of triboluminescence seen as a flash of light when a crystal of such substances is crushed between two glasses. But this is not quite exclusively the case, because crystals of uranium-nitrate, and perhaps other crystallised salts of uranium, emit a very bright greenish-yellow flash when pressed to pieces between glass plates. The property seems permanent in these crystals, and it is also apparently independent in them of chemical impurities, since any crystallised sample of the nitrate, as far as I have tried, shows the light flash very strongly, without any apparent loss of brightness by long keeping.

The ruddy light which gleams from under glass or from a flint pebble when ground with strong pressure on a grindstone, must apparently be a true example of luminescence produced by friction, since it is equally visible under water on a thoroughly wet, as on a dry, grindstone, where it can hardly be supposed to result from high temperature producing actual incandescence. But examples of crystals which emit light by fracture do not, it appears, present themselves in nearly such abundance among mineral substances, as they have now been shown in the above-mentioned paper to do in so many cases among organic bodies.

A rather interesting observation of thermoluminescence once befel me while making trials of that property in minerals; and as it may afford, perhaps, a ready means of tracing lime or calcareous ingredients in certain minerals, it may be useful to mention it here, although the mode of excitation used in that instance was not by crushing or rubbing, but by heating the material. Some fine dust and grains obtained from the interior portion of the mass of the Middlesborough aërolite, when the meteorite was first being chemically and microscopically examined, were found, to my considerable surprise, to glow quite distinctly, though not very brightly, with yellowish-white light, when sprinkled in the usual way for these experiments on a piece of nearly red-heated iron in the dark. No such luminescence would, I believe, be evolved by that means from pure terrestrial specimens of the pair of double silicates of magnesia and iron (olivine and bronzite, much less from the moderate sprinkling of nickel iron, and perhaps of iron-sulphide found with them), of which the stony matter of the meteorite in the main consists. But as its stony mass was considered, in the exact chemical analysis of the meteorite made by Dr. Flight,[1] to contain probably, besides, an appreciable amount of labradorite or lime-felspar, the source of the light may have been this calcareous ingredient of the stone, as calciferous rocks and minerals, for the most part, shine brightly with various shades from light- to reddish-yellow, in the dark, when strongly heated. To whatever chemical materials in the stone, however, the light was really due, it afforded, at all events, clear proof that no heat of exceedingly high temperature can ever have penetrated to the interior of the meteorite, even when it was passing at its fall, in a fireball through the atmosphere, since the time when it was broken off from some parent rock and projected on a celestial course about the sun; for a very moderate degree of heat suffices to expel completely from minerals of these luminescent natures all the store of thermoluminescent energy which, either originally communicated to them from without by radiation near some exposed or denudated surface, or else contracted by them in some more mysterious way at great subterranean depths, they more or less abundantly possess. A. S. HERSCHEL.

Observatory House, Slough, April 27.

The New Zealand Godwit (*Limosa novæ-zelandiæ*).

THE Maori of New Zealand have an ancient saying or proverb, "Who can tell where the kuaka (the godwit) has its nest?" No doubt the Maori were well acquainted with the singular habit of these birds, in that they leave the shores of New Zealand, for a distant land across the seas, about the same time that other migratory birds, which have wintered on the Pacific Islands located nearer the tropics, are nesting and

[1] *Proceedings* of the Royal Society, vol. xxxiii., p. 347, February 1882.

rearing their young in the New Zealand forests, to which country they periodically return for the summer season. Such, for example, are the long-tailed cuckoo and the small bronze-cuckoo, known to the Maori as "the bird of Hawaiki"—that is, the bird who returns to the land from whence the Maori ancestors originally came.

Our kingfisher also moves northward in the autumn, and may likewise leave for a warmer country. These latter birds conduct their migrations as we should expect—that is, they reverse the conduct of their flight to those birds which live in northern latitudes, and we feel that their natural instincts are working according to rule. But the kuaka, not satisfied to pass the winter in a warmer country, must actually have two summers—one in New Zealand and a second in Northern Siberia, where it is said to have its breeding-place. Any way, it leaves in countless numbers from the north-east point of New Zealand, from almost the very place where the spirits of the dead Maori are supposed to take their departure to the other world (Reinga). For which reason the bay on the shore of which the birds assemble before flight is named by Europeans "Spirits' Bay."

The Polynesian mariner may in former times have guided his migrations by observation of the place of departure and arrival of birds of passage, also from the particular dates of such occurrence, and from the circumstance that the winds at that time were most favourable for travel in such particular directions. The spirits of their dead may have been supposed to return to the original birthplace of the race; and the nearest point of departure would be that from which the birds also departed.

But do any migratory birds other than the kuaka go further north than Tahiti, Rarotonga, Samoa, and the Fijis?

I always understood that no bird from either the north or the south temperate zones ever voluntarily crossed the tropics, and to me it seems a fable that even the kuaka should do so.

Whence comes the hereditary knowledge that should lead the kuaka half over the world to find a suitable breeding-place? Why does it not go in search of an Antarctic continent, as should be the natural sequence of events? Are not the high lands and alpine valleys of New Zealand where the dotterel, the red-breasted plover, the stilt-plover, oyster-catcher, &c., make their nests, equally suitable for the godwit?

Where does the European godwit (*Limosa lapponica*) breed? and is it not said that the nesting-place of the European knot (*Tringa canutus*) has never been discovered?

That the New Zealand godwit starts in a northerly direction in its migration is assured; but who has traced its course onward, as following the shores of China, it is making its way to lonely steppes in Siberia?

That these birds should winter during a New Zealand summer, and then leaving should pass through both temperate and torrid zones, and still onward to the confines of the north frigid zone to nest and summer, is truly marvellous. Will any reader of NATURE kindly contribute to our knowledge of the nesting-place of the godwit or the knot, or remark on other points at issue?

TAYLOR WHITE.

Wimbledon, Hawkes Bay, N.Z., February 9.

[In reference to the above, the British Museum possesses a single egg of the knot, said to be one out of a clutch of four obtained at Disco Island, Greenland. Colonel Feilden has good grounds for believing that this bird nests in the New Siberian Islands.—ED.]

The Indian Musk-Shrew.

THE old yarn about the tainting of wine in bottle by the common Indian shrew (*Crocidura coerulea*)) seems to die hard, since "W. T. B." has had to correct it again in your issue of this week. The account of a crucial and deliberate experiment may be another nail in its coffin.

I kept wine in small chambers off my office, in a locked basket, ventilated at the ends, for use at luncheon. One day I opened it, and found a musk-shrew coiled up on a napkin, and did not disturb him, nor he himself. Next day I impanelled an unconscious jury; and we found the wine perfectly good. The musk-rat had been there in the morning, but had received a quiet hint to go. When my guests were gone, I wiped a glass with his napkin, filled it with wine from the same bottle, and found this too musky to swallow.

The wine was a sound Pommard from Treacher and Co., Bombay, with capsuled corks bearing their stamp.

I do not know whether it was bottled in Europe or in India. I believe that the commonest cause of the musk-taint in wine is the wiping of the glass with a clout that has been picked up out of a corner, where the musk-shrew has laid on it.

Even in the best houses in India native servants will often use very little care about the cleanliness of "glass-cloths"; and when one that has served to clean a lamp or shelter a shrew is next used upon a wineglass, you have *vera et sufficiens causa* for spoilt wine—and temper.

I have a note on this somewhere in the *Journal* of the Bombay Natural History Society; but it is buried out of sight in some back volume, as my experiment took place about twenty years ago. I may add that the place of it was Ahmadabad, in Gujarat.

W. F. SINCLAIR.

102 Cheyne Walk, Chelsea, London, S.W., May 5.

Mammalian Longevity.

SINCE my letter on this subject in NATURE of March 23, I have noticed that a slight change in the formula—the reduction of the constant from 10·5 to 10·1—gives much better results. The agreement is now very close indeed. The amended statement now runs as follows:—

The full term of life in any mammalian species is equal to 10·1 times its period of maturity divided by the cube root of the period, or 10·1 times the cube root of the square of the period.

We get the following results from its application:—

Animal.	Observations.			f. t. l. by formula.	Other observations.
	Authority.	p. m.	f. t. l.		f. t. l.
Dom. Mouse ..	Dr. Ainslie Hollis.	·25 yr	4 yr.	4 (4·01)	
Guinea-pig ...	Flourens.	·583	6–7	7 (7·05)	
Lop-Rabbit—					
Buck... ...	R. E. Edwards.	·75	8	8 (8·3)	
Doe	R. E. Edwards.	·67	8	8 (7·7)	
Goat	Pegler.	1·25	12	12	
Fox	St. G. Mivart.	1·50	13–14	13·25	
Cat	Jennings.	2	15	16	
Cattle	Dr. Ainslie Hollis.	2	18	16	14, Gresswell. 15-20, Flourens.
Large Dogs ...	Dalziel.	2	15	16	15-20, Flourens and others.
Thor. Horse ...	Dr. Ainslie Hollis.	4·5	30	28	
Pigs	James Long.	5	30	30	
Hippopotamus	Chamb. Encyc.	5	30	30	
Lion	St. G. Mivart.	6	30–40	33	
Hunter... ...	Blaine.	6·25	33	34	
Arab Horse ...	Dr. Ainslie Hollis.	8	40	40	
Camel	Flourens.	8	40	40	
Man	Buffon.	25	90–100	86	100, Flourens. 75, Farr.
Elephant ...	Darwin.	30	100	98	
Elephant ...	C. F. Corder and Indian hunters.	35	120	108	100, Darwin.

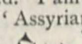
In this table, p. m. stands, as before, for period of maturity, and f. t. l. for full term of life.

In the first table another statement dealing with the cat was also given, on the authority of Dr. Mivart, which is excluded from this, since the period mentioned—one year—obviously refers to the animal's period of puberty, not its period of maturity, as is indicated by Dr. Mivart's expression: "The domestic cat begins to be ready to reproduce by the end of the first year of her life. . . ."

The age of the hunter, calculated from Blaine, was given in the previous table at thirty-five, and in this it is given at thirty-three. Blaine states that a horse of thirty years is relatively as old as a man of eighty, and a horse of thirty-five as a man of ninety. The first formula gave about ninety for man, and the corresponding age for the horse was therefore thirty-five; but the corrected formula gives eighty-six for man, which corresponds to thirty-three in the horse.

I agree with Dr. Ainslie Hollis that Buffon's 90-100 years for man is too long; but, on the other hand, seventy-five—the period given by Dr. Hollis from Dr. Farr's calculations—seems much too short. The great majority of persons have their lives cut short by disease, the nervous strain of life, &c., and do not live to anything like the full term of life. Were it not for such influences as these, most persons at seventy-five would probably still possess a considerable degree of vitality, and should be able to look forward to many years of life. Furthermore, Farr's calculation is based on what seems a faulty method. The average of life, about fifty years, is taken, and the expectation of life (in reality a somewhat larger figure), twenty-five years, is added, making up seventy-five, the manifest assumption being that the full term of life of a species is equal to its *average* life plus the *expectation of life* at that age, a conception for which I know of no physiological justification. Eighty-six to eighty-seven years, the period given by the formula, probably represents with fair accuracy the average age at which people would pass from life by senile decay if their lives were not shortened by deleterious influences and conditions. ERNEST D. BELL.

"Primitive Constellations."

REFERRING to your reviewer's hostile notice of my work, "Primitive Constellations," I have seldom realised the strength of my general position until I have seen some attack on it. Against my main contention, *i.e.* the identity of various Greek and Babylonian constellations, he has nothing to say, except that I start with my "theory ready made." Really, he does me much honour. Am I the inventor of the "theory" that, *e.g.*, the signs of the Zodiac were derived from Babylonia? But, leaving nine-tenths of the book with merely a little abuse, he has much to say on the transliteration of Babylonian words, and expresses great scorn because, following Prof. Sayce, I deliberately write *sa*, and not *sha*, and so on. He says I "really ought to know there is no *h* in Assyrian." Indeed. I am at present away from books, but happen to have Sayce's "Assyrian Grammar" at hand. At p. 46 I read, "*a, ha*  . . . *h.* , *ah, hi, h.*" Again, I am perfectly aware of the force of "the determinative particle *ki*," and, in a book for general readers, have naturally chosen to write "Barsipki," not "Barsip[ki]," "Suanaki," "Tintirki," &c. If the critic had endeavoured to refute my general proposition, or had carefully examined my treatment of any particular constellation figure, *e.g.* the *Arrow*, how much more useful it would have been. But a policy of pin-pricks does not venture on this.

Berry Pomeroy, Boscombe, April 18. R. BROWN, JUN.

THE writer of the review did not suggest that Mr. Brown had discovered the Babylonian origin of the signs of the Zodiac. The theory which the reviewer laid to his charge was to the effect that the Greeks of the pre-Homeric and Homeric ages had a full knowledge of the constellations known to their descendants in Ptolemaic times; and, further, that they obtained such knowledge at this early period from the Babylonians through intercourse with the Phœnicians and the "Hittites." It is from this theory that the reviewer entirely dissents. Mr. Brown's wholesale assertions that representations of animals in early Greek art are astronomical symbols it was thought might be charitably explained by supposing that he began his studies with this part of his theory "ready made." Of the two cuneiform signs which Mr. Brown cites as proving the existence of the *h* in Assyrian, the first only represents the vowel *a*, the second is only used to indicate the smooth breathing; that he should rely on a grammar published more than twenty years ago shows that he has not made himself acquainted with the recent literature on this subject. It is satisfactory to learn that Mr. Brown is aware of the force of the determinative particle *ki*; but to transliterate such a determinative (which was not pronounced) as though it formed a syllable of the word to which it is attached is, to say the least, misleading—particularly so in a book for general readers. Mr. Brown's numerous blunders in citing Hebrew, Phœnician, and Assyrian words, show that he is not acquainted with these languages at first hand; and it was stated that such a knowledge is essential to a writer who treats the subject of Babylonian astronomy from the linguistic side.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following are the names and qualifications of the fifteen candidates selected by the Council of the Royal Society, to be recommended for election into the Society this year:—

W. F. BARRETT,

F.R.S.E., M.R.I.A., Professor of Experimental Physics in the Royal College of Science for Ireland, Memb. Physical Society, Royal Dublin Society, and of General Committee of the British Association. Author of numerous original investigations and papers; amongst them are:—"The discovery of certain physical phenomena produced by the contact of a hydrogen flame with various bodies, and its application as a delicate chemical re-agent" (*Phil. Mag.*, November, 1865); "The discovery and investigation of a serious source of error in the determination of the absorption of heat by liquids" (*ibid.*, September, 1868); "The discovery and investigation of sensitive flames" (*ibid.*, March and April, 1867); "The application of sensitive flames as a delicate acoustic re-agent in illustrating the laws of the reflection, refraction, and interference of sound-bearing waves and the detection of inaudible vibrations" (*Proc. Roy. Dubl. Soc.*, January, 1868; *Science Review*, April, 1867; NATURE, May, 1877); "The discovery of recalescence and other molecular changes in iron and steel when raised to a bright heat" (*Phil. Mag.*, December, 1873; Brit. Assoc., 1890); "The investigation of the molecular changes accompanying the magnetisation of iron, nickel, and cobalt, and the discovery of the retraction of nickel, and the elongation of cobalt by magnetisation, with the determination of its amount" (*Phil. Mag.*, December, 1873, and January, 1874; Brit. Assoc., 1873, 1874, and 1882; *The Electrician*, October, 1882; NATURE, October, 1882); "The investigation of the magnetic properties and the determination of the physical constants of various alloys of manganese steel" (Brit. Assoc., 1887 and 1889; *Proc. Roy. Dubl. Soc.*, November and December, 1889, March, 1886, and in *The Electrician*). Also brief papers on the spheroidal state (*Proc. Roy. Dubl. Soc.*, December, 1877); on the magnetic properties of columnar basalt (*ibid.*, December, 1889), and on the magnetic moment of ingots of manganese steel (*ibid.*, December), &c.

CHARLES BOOTH,

Hon. Sc.D. (Camb.), Merchant and Shipowner. As having applied Scientific Methods to Social Investigation, exemplified by:—(1) A Study of Changes in the Occupations of the People in England, Scotland, and Ireland, from 1841 to 1881 (*Journ. of Statistical Soc.*, 1886); (2) A Study of the Condition of the Aged Poor in England and Wales from Official Statistics and Extended Private Enquiry ("The Aged Poor," Macmillan, 1894); (3) A Study of the Condition of the People of London, 1889 to 1899, in twelve volumes, of which nine are already published ("Life and Labour of the People in London," Macmillan).

DAVID BRUCE,

M.B., Surgeon-Major, Army Medical Staff. Has made important investigations relating to the nature and causes of Malta Fever, and discovered the micro-organism which is the cause of that disease, and proved its nature by experiment. Has successfully investigated the endemic disease of horses in Zululand, and proved the agency of the Tsetse Fly in producing it. Author of the following papers: "Discovery of a Micro-organism in Malta Fever" (*Practitioner*); "Sur une Nouvelle Forme de Fiévre rencontrée sur les Bords de la Mediterranée" (*Annales de l'Inst. Pasteur*); "On the Epidemic of Cholera in Malta during 1887" (*Trans. Epidem. Soc.*); "Report (to the Governor of Natal) on the Tsetse Fly Disease or Nagana" (1897); and a previous Report on the same subject; "Ueber die Virulenzsteigerung des Cholera Vibrio" (*Centralblatt f. Bacteriologie, &c.*). Eminent in Pathology and Bacteriology.

HENRY JOHN HORSTMAN FENTON,

M.A. (Camb.). Author of several papers on the action of hypochlorites and hypobromites on urea and other nitrogen compounds. Has made the remarkable discovery that hydrogen peroxide, although inactive alone, in presence of an iron salt, at once oxidises tartaric and other similar acids, carbohydrates, &c., giving rise to very characteristic products—a discovery of special importance in connection with plant metabolism, which he has elaborated with particular skill and thoroughness. His results are described in the following papers:—"Oxidation of Tartaric Acid in Presence of Iron" (*Trans. Chem. Soc.*, 1894); "A New Method of obtaining Dihydroxytartaric Acid, and the use of this Acid as a Re-agent for Sodium" (*ibid.*, 1895); "New Formation of Glycollic Aldehyde" (*ibid.*); "The Constitution of a New Dibasic Acid resulting from the Oxidation of Tartaric Acid" (*ibid.*, 1896); "A New Synthesis in the Sugar Group" (*ibid.*, 1897); "Properties and Relationships of Dihydroxytartaric Acid," I. and II. (*ibid.*, 1898); "The Oxidation of Polyhydric Alcohols in presence of Iron" (*ibid.*, 1899).

James Sykes Gamble,

M.A. (Oxon.), F.L.S. Conservator of Forests, School Circle, N.W. Provinces, India, and Director of the Imperial Forest School, Dehra Dun. Fellow of the University of Madras, and *ex-officio* Fellow of the University of Allahabad. Author of a List of Trees, Shrubs, &c., of the Darjeeling District, Bengal (1st edit., 1877; 2nd edit., 1896); a Manual of Indian Timbers, published in 1881; a Monograph of the Bambuseae of British India, 1896. Also many papers on Forestry and on Botanical subjects in the "Indian Forester," which he has long edited.

Alfred Cort Haddon,

M.A., M.R.I.A., F.Z.S. Professor of Zoology, Royal College of Science, Dublin. Vice-President of the Royal Zoological Society of Ireland. Member of Council of the Royal Dublin Society, Anthropological Institute and Folk-lore Society. Has considerably extended our knowledge of the Marine Fauna of Ireland (*Proc. Roy. Irish Acad.*, 1886–87). Received a grant from the Royal Society and spent eight months (1888–89) in studying the Marine Zoology, Geology and Ethnography of Torres Straits. Has made investigations upon British and Tropical Actiniaria (*Journ. Linn. Soc.*, xxi.; *Proc. Roy. Dubl. Soc.*, 1885–92, *Trans.*, 1889–92). Is the author of a memoir on "The Air-bladder and Weberian Ossicles in Siluroid Fishes" (with Prof. Bridge) (*Phil. Trans.*, 1893); "Report on the Polyplacophora collected by H.M.S. *Challenger* (Part XLIII., 1886); "Notes on the Development of Mollusca" (*Quart. Journ. Micros. Sci.*, 1882); and other papers on Marine Zoology. Has made a map and a geological survey of the Murray Islands, Torres Straits, which, with other geological observations, are published in the *Trans. Roy. Irish Acad.* in a joint memoir with Prof. Sollas and Prof. Cole. Has carried out extensive and detailed anthropological investigations on the mode of life, handicrafts, religion, and languages of the natives of Torres Straits (*Journ. Anthrop. Inst.*, 1891; *Proc. Roy. Irish Acad.*, 1893; *Folk-lore*, 1890; *Internat. Arch. f. Ethnogr.*, 1892–93). Has organized a scheme for the systematic study of Irish Ethnography (the Ethnography of the Aran Islands; Studies in Irish Craniology—Part I. Aran, II. Inishbofin. *Proc. Roy. Irish Acad.*, 1893–94). Has made an elaborate study of the evolution and degeneration and geographical distribution of the Decorative Art of British New Guinea (Cunningham Memoir Roy. Irish Acad.).

Henry Head,

M.D. (Cantab.), M.A., M.R.C.P., M.R.C.S. Author of the following papers:—"Ueber positive und negative Schwankungen des Nerven Stromes" (*Pflüger's Archiv*, 1887); "Regulation of Respiration," Parts I.–II. (*Journ. Physiol.*, vol. x.); "On Disturbances of Sensation, with especial reference to the Pains of Visceral Disease" (Part I., *Brain*, 1893, Part II., *Brain*, 1894).

Conwy Lloyd Morgan,

F.G.S. Professor of Biology and Geology, University College, Bristol, and Principal of the same College. Correspondent of the Academy of Sciences of Philadelphia and New York. As a geologist, Prof. Lloyd Morgan has done a considerable amount of original work in Pembrokeshire and the Bristol district. His chief claim to scientific distinction, however, rests upon his careful experiments and observations on the habits, instincts, and intelligence of Animals, and his critical study of the true biological significance of the facts and their bearing upon some of the most fundamental problems of Organic Evolution. The three volumes which he has published on these subjects are of very high merit, and, in the opinion of the signers of this certificate, place their author in the first rank as a philosophical biologist. Author of the following memoirs:—(1) "Animal Life and Intelligence," 1890; (2) "An Introduction to Comparative Psychology," 1894; (3) "Habit and Instinct," 1896; and of the following geological papers:—"On the Pebidian Volcanic Series of St. David's" (*Quart. Journ. Geol. Soc.*, vol. xlvi., 1890); "On the S.W. Extension of the Clifton Fault" (*ibid.*, vol. xli., 1885); and twelve geological papers in the *Proc. Bristol Nat. Soc.*, 1884–90, and other local scientific periodicals.

Clement Reid,

F.G.S., F.L.S. Geologist in the Geological Survey of England and Wales, and has served on the Staff since 1874. Awarded the Murchison Fund by the Council of the Geological Society in 1886. Has been Secretary and Recorder to the Geological Section of the British Association. Has added largely to our knowledge of the Lower Tertiary formations of the Isle of Wight and Dorset, the Pliocene deposits of Norfolk and the North Downs (including the fauna and flora of the Cromer Forest Bed), and the Glacial Phenomena of Norfolk and Sussex. To aid his researches he has made a special study of recent and fossil seeds (a subject previously much neglected), whereby much light has been thrown on the climatic conditions of later Tertiary times, and on the origin of the British flora. Author of Geological Survey memoirs on "Geology of the Country around Cromer," 1882; "Geology of Holderness," 1885; "Pliocene Deposits of Britain," 1890, and revised Tertiary portion of "Geology of Isle of Wight," 2nd ed., 1889. Also author of many original papers, including "Dust and Soils" (*Geol. Mag.*, 1884); "Norfolk Amber" (*Trans. Norf. Nat. Soc.*, 1884); "Origin of Dry Chalk Valleys" (*Quart. Journ. Geol. Soc.*, 1887); "Geological History of the Recent Flora of Britain" (*Ann. Botany*, 1888); "Pleistocene Deposits of Sussex Coast" (*Quart. Journ. Geol. Soc.*, 1892); "Natural History of Isolated Ponds" (*Trans. Norf. Nat. Soc.*, 1892); "Desert or Steppe Conditions in Britain" (*Nat. Science*, 1893); "Eocene Deposits of Dorset" (*Quart. Journ. Geol. Soc.*, 1896); "Report on Relation of Palæolithic Man to the Glacial Epoch" (Hoxne Excavation) (Brit. Assoc., 1896).

Henry Selby Hele Shaw,

LL.D. (St. And.), Engineer. Mem. Inst. C.E., Mem. Inst. M.E., F. R. Met. Soc., Harrison Professor of Engineering, University College, Liverpool. Senior Whitworth Scholar, 1876, and Miller Scholar of the Inst. C.E. Distinguished for his acquaintance with Engineering and Mechanical Science. Inventor of integrating and power transmitting mechanism. Was the first Professor of Engineering at Bristol and afterwards at Liverpool. At Liverpool he organised the School of Engineering and designed and supervised the equipment of the Walker Engineering Laboratories, in which there are now nearly 100 day students under instruction. Author of "Theory of Continuous Calculating Machines" (*Phil. Trans.*, 1884); also of the following communications:—"On Small Motive Power" (Inst. Civil Engineers, 1880); "On the Measurement of Velocity for Engineering Purposes" (*ibid.*, 1882); "On Mechanical Integrators" (*ibid.*, 1885) (awarded the Watt Gold Medal and Telford premium); "Sphere and Roller Mechanism," jointly with Mr. E. Shaw (Brit. Assoc., 1886); "First Report on Graphical Methods in Mechanical Science" (*ibid.*, 1891); "Second Report on the Development of Graphical Methods in Mechanical Science" (*ibid.*, 1892); "Third Report on Graphical Methods" (*ibid.*, 1893); "Experimental Investigation of the Motion of a Thin Film of Viscous Fluid," appendix by Sir G. G. Stokes, F.R.S. (*ibid.*, 1898); "A New Instrument for Drawing Envelopes, and its Application to the Teeth of Wheels, and for other Purposes" (*ibid.*, 1898); "Rolling Contact of Bodies" (Roy. Inst., 1887, Friday evening Discourse); "The Motion of a Perfect Fluid" (*ibid.*, 1899, Friday evening Discourse); "Experiments on the Nature of Surface Resistance in Pipes and on Ships" (Inst. Naval Architects, 1897); "Investigation of the Nature of Surface Resistance of Water, and of Stream Line Motion under Certain Experimental Conditions" (*ibid.*, 1898) (awarded the Gold Medal of the Institution); "Experimental Marine Engine and Alternative-centre Testing Machine in the Walker Engineering Laboratory" (Inst. Mechanical Engineers, 1891); and other papers to the Society of Arts, Physical Society, and Societies in Bristol, Liverpool and elsewhere.

Ernest Henry Starling,

M.D., F.R.C.P., Joint Lecturer on Physiology, Guy's Hospital, Lecturer on Physiology, London School of Medicine for Women. Distinguished as a Physiologist. Author of the following: "Electromotive Phenomena of the Mammalian Heart" (*Proc. Roy. Soc.*, vol. l., and *Internat. Journ. of Anat. and Physiol.*, vol. ix., with W. M. Bayliss); "Innervation of Mammalian Heart" (*Journ. of Physiol.*, vol. xiii., with W. M. Bayliss); "Fate of Peptone in Blood" (*Proc. Physiol. Congress, Liége*, 1892); "Physiology of Lymph Secretion" (*Journ. of Physiol.*, vol. xiv.); "Absorption and Secretion in Serous Cavities" (with A. H. Tubby, *ibid.*, vol. xvi.); "Nervous and Capillary Pressures" (with W. M. Bayliss, *ibid.*, vol. xvi.); "Mechanical Factors in Lymph Production" (*ibid.*, vol. xvi.);

"Action of Lymphagogues" (*ibid.*, vol. xvii.); "Vaso-Constrictors of Portal Vein" (with W. M. Bayliss, *ibid.*, vol. xvii.); "Intraventricular and Aortic Pressure Curves by a New Method" (with W. M. Bayliss, *Internat. Journ. of Anat. and Physiol.*, vol. xi.); "Osmotic Pressures and Physiol. Problems" (*Science Progress*, 1896); "Absorption from Pleural Cavities" (with J. B. Leathes, *Journ. of Physiol.*, vol. xviii.); "Production of Pleural Effusion" (*Journ. of Pathol.*, vol. iv.); "Absorption from Connective Tissue Spaces" (*Journ. of Physiol.*, vol. xix.); "Ligature of Portal Lymphatics and Injection of Peptone" (*ibid.*, vol. xix.); "Absorption of Indigo Carmine from Peritoneal Cavity" (*Proc. Physiol. Soc.*, 1898, Arris and Gale Lectures); "Physiol. of Lymph Formation," 1894; "Causation of Dropsy," 1896; "Pathol. of Heart Disease," 1897. Author of "Elements of Human Physiol.," 3rd edit., 1897; of the following articles in Schäfer's Text-book of Physiology: "Formation and Absorption of Lymph"; "Secretion of Urine"; "Special Muscular Mechanisms of Respiration, Alimentation, Micturition," &c. Editor of Metschnikoff's Lectures on Pathology of Inflammation. Joint Editor of the Collected Works of L. C. Wooldridge.

HENRY WILLIAM LLOYD TANNER,

M.A. (Oxon.), F.R.A.S., A.R.S.M., Professor of Mathematics and Astronomy in the University College of South Wales and Monmouthshire, Member (and sometime Member of Council) of the London Math. Soc. Distinguished as a mathematical investigator, author of several papers on "Differential Equations" (*Proc. Lond. Math. Soc.*, vols. vii., viii., ix., x., xi.; *Quart. Journ. Math.*, vol. xvi.; *Mess. Math.*, vols. v., vi., vii.); "On Determinants of n Dimensions" (*Proc. Lond. Math. Soc.*, vol. x.); "On the Coordinates of a Plane Curve in Space" (*ibid.*, vol. xiii.); "On the Function $(ax + b)(cx + d)$" (*Mess. Math.*, vol. ix.); "On Spherical Trigonometry" (*ibid.*, vol. xiv.); "Sturm's Theorem" (*ibid.*, vol. xviii.); "Solution of $(a, b, \ldots, c) = (a^p, b^p, \ldots, c^p)$" (*ibid.*, vol. xix.); "Arbogast's Rule" (*ibid.*, vol. xx.); "Square Roots of Unity for a Prime Modulus" (*ibid.*, xxi.); "Quinquisection of $x^p - 1$" (*Proc. Lond. Math. Soc.*, vol. xviii.); "Cyclotomic Functions" (*ibid.*, vol. xx.); "Approximate Evolution" (*ibid.*, vol. xxiii.); "Complex Primes formed with Fifth Roots of Unity" (*ibid.*, vol. xxiv.).

RICHARD THRELFALL,

M.A., late Professor of Experimental Physics, University of Sydney, New South Wales. Author of the following papers: "On the Electrical Properties of Pure Sulphur" (in conjunction with Mr. Brearly, *Phil. Trans.*, 1896); "On the Conversion of Energy in Dielectrics" (*Physical Review*, vol. iv.); "On the Behaviour of Oxygen at Low Pressures" (*Phil. Mag.*, 1897); "On the Scattering of Light by Metallic Particles" (*ibid.*, vol. xxxviii.); "On an Approximate Method for Finding the Forces on Magnetic Circuits" (*ibid.*); "On the Electrical Properties of Pure Nitrogen" (*ibid.*, vol. xxxv.); "On the Elastic Properties of Quartz Threads" (*ibid.*, vol. xxx.); "On the Measurement of High Specific Resistances" (*ibid.*, vol. xxviii.); "On the Clark Cell as a Source of Small Constant Currents" (with Mr. Pollock, *ibid.*); "On the Specific Heat of the Vapours of Acetic Acid and Nitrogen Tetroxide" (*ibid.*, vol. xxiii.); "On the Theory of Explosives" (*ibid.*, vol. xxi.); "On the Velocity of Transmission through Sea Water of Disturbances of Large Amplitude caused by Explosives" (*Proc. Roy. Soc.*, vol. xlvi.); "On the Effect produced by the Passage of an Electric Discharge through Nitrogen" (with Prof. J. J. Thomson, *ibid.*, 1886); "Some Experiments on the Production of Ozone" (with Prof. J. J. Thomson, *ibid.*); "Laboratory Arts" (Macmillan and Co., 1898). Introducer of improvements in the Microtome.

ALFRED E. TUTTON,

F.C.S., Associate Royal College of Science. Member Mineral. Soc. Inspector, Science and Art Department. Has made discoveries in crystallography, and has invented instruments for research in this branch of science. Is the author of the following papers: "Connection between Atomic Weight of Contained Metals and the Magnitude of the Angles of Crystals of Isomorphous Series. A Study of the Potassium, Rubidium, and Caesium Salts of the Series $R_2M(SO_4)_2, 6H_2O$" (*Journ. Chem. Soc.*, 1893, p. 337: and *Zeits. für Kryst.*, vol. xxi., p. 491); "An Instrument for Grinding Section-Plates and Prisms of Crystals of Artificial Preparations Accurately in the Desired Directions" (*Phil. Trans.*, 1894A, p. 887, and *Zeits. für Kryst.*, vol. xxiv., p. 433); "An Instrument for Producing Monochromatic Light of any Desired Wave-Length, and its use in the Investigation of the Optical Properties of Crystals" (*Phil. Trans.* 1894A, p. 913; and *Zeits. für Kryst.*, vol. xxiv., p. 455); "Connection between the Atomic Weight of Contained Metals, and the Crystallographical Characters of Isomorphous Salts. The Volume and Optical Relationships of the Potassium, Rubidium and Caesium Salts of the Series $R_2M(SO_4)_2, H_2O$" (*Journ. Chem. Soc.*, 1896, p. 344; and *Zeits. für Kryst.*, vol. xxvii., p, 113); "Comparison of the Results of the Investigations of the Simple and Double Sulphates, and General Deductions concerning the Influence of Atomic Weight on Crystal Character" (*Journ. Chem. Soc.*, 1896, p. 495; and *Zeits. für Kryst.*, vol. xxvii., p. 252); "Connection between the Crystallographical Characters of Isomorphous Salts and the Atomic Weight of the Metals Contained. A Study of the Normal Selenates of Potassium, Rubidium, Caesium" (*Journ. Chem. Soc.*, 1897, p. 846; and *Zeits. für Kryst.*): and of various papers in the *Journal* of the Chemical Society and other journals. Author of the following Memoirs, in conjunction with Prof. Thorpe: "Phosphorus Tetroxide" (*Journ. Chem. Soc.*, 1886, p. 833); "Phosphorus Oxide, Part I." (*ibid.*, 1890, p. 545); "Phosphorus Oxide, Part II." (*ibid.*, 1891, p. 1019); "Ueber Phosphoroxysulfid" (*Zeits. Anorg. Chem.*, 1892-5).

BERTRAM COGHILL ALLEN WINDLE,

M.D., M.A., D.Sc. (Dublin). Professor of Anatomy, Queen's College, Birmingham. Has devoted himself to the study of Human and Comparative Anatomy and Morphology; and has published the following works and papers on these and kindred subjects:—(1) "On the Embryology of the Short Muscles of the Manus and Pes of the Dog" (*Proc. R. Irish Acad.*, vol. iii.); (2) "The Embryology of the Short Muscles of the Human Hand" (*Trans. R. Irish Acad.*, xxviii.); (3) "On the Pectoral Group of Muscles" (*ibid.*, xxix.); (4) "Teratological Evidence as to the Heredity of Acquired Characters" (*Journ. Linn. Soc.*, xxiii.); (5) "On the Anatomy of *Hydromys chrysogaster*" (*Proc. Zool. Soc.*, 1887); (6) "On some Cranial and Dental Characters of the Domestic Dog" (in conjunction with Mr. Humphrys) (*ibid.*, 1890); (7) "On an Abnormal Arrangement of the Large Intestine" (*Journ. of Anat.*, vol. xx.); (8) "On Primary Sarcoma of the Kidney" (*ibid.*, xix.); (9) "On the Condition of the Brain in a case of Motor Aphasia with Deafness" (*ibid.*, new series, i.); (10) "Man's Lost Incisors" (*ibid.*, i.); (11) "Anomalies of Muscles and Nerves" (*ibid.*); (12) "Two Rare Tumours connected with the teeth" (*ibid.*); (13) "The Myology of *Erethizon epixanthus*" (*ibid.*, ii.); (14) "On the Arteries forming the Circle of Willis" (*ibid.*); (15) "On a Teratoma from the Sphenoid of a Calf" (*ibid.*); (16) "On the Myology of *Procyon cancrivorus*, and others of the Ursidæ" (*ibid.*, iii.); (17) "On the Origin of Double Monstrosities" (*ibid.*); (18) "On the Flexors of the Digits of the Hand" (*ibid.*, iv.); (19) "Ununited Epiphyses" (*ibid.*); (20) "On the Stylo-auricularis Muscle and Ligament" (*ibid.*, v.); (21) "On the Occurrence of an Additional Phalanx in the Human Pollex" (*ibid.*, vi.); (22) "On Identical Malformations in Twins" (*ibid.*); (23) "Sacculation of the Human Stomach" (*Proc. Birmingham Philos. Soc.*, v.); (24) "Myology of *Midas rosalia*" (*ibid.*); (25) "Myology of *Hapale Jacchus*" (*ibid.*); (26) "The Adductor Muscles of the Hand" (*ibid.*); (27) "The Extensors of the Manus in the Ape" (*ibid.*, vi.); (28) "On Congenital Malformation and Heredity" (*ibid.*); (29) "Researches on the Maturation of the Ovum" (*ibid.*); (30) "Certain Malformations in Fishes" (*ibid.*); (31) "Investigations in Artificial Teratogeny" (*ibid.*, vii.); "Extra Cusps on Human Teeth" (*Anat. Anzeiger*, vol. ii.); (33) "Congenital Deficiency of Thumb" (*ibid.*, iii.); (34) "Malformations of the Face" (*ibid.*, iv.); (35) "Musculus sternalis" (*ibid.*); (36) "The Human Skull" (*Birmingham Med. Review*, vol. xviii.); (37) "Hermaphroditism" (*ibid.*, xx.); (38) "Development of Intermaxillary Bone" (*ibid.*, xxv.); (39) "A Manual of Surface-Anatomy" (London, H. K. Lewis, 1888); (40) "The Proportions of the Human Body" (London: Baillière, Tindall, and Cox, 1892).

Supplementary Certificate.—"On the Myology of the Pneucephalous Fœtus" (*Journ. of Anat. and Physiol.*, vol. xxvii.

p. 348); "On Certain Early Malformations of the Embryo" (*ibid.*, p. 436); "On some Conditions related to Double Monstrosity" (*ibid.*, vol. xviii., p. 25); "The Effects of Electricity and Magnetism on Development" (*ibid.*, vol. xxix., p. 346); "On the Myology of *Dolichotis Patagonica* and *Dasyprocta Isthmica*" (*ibid.*, vol. xxxi., p. 343); "On some Points in Comparative Myological Nomenclature" (*ibid.*, vol. xxxi., p. 522); "On the Anatomy of *Macropus Rufus*" (*ibid.*, vol. xxxii., p. 119); "On a Specimen of Bifid Clitoris" (*Proc. Anat. Soc. Gt. Brit.*, 1893, vol. xxii.); "On the Cusps of the Aortic Pulmonary Orifices" (*ibid.*, 1895, vol. iv.); "On the Double Malformations amongst Fishes" (*Proc. Zool. Soc.*, 1895, p. 423); "On the Myology of the Terrestrial Carnivora.—Part I., Muscles of the Head, Neck and Fore-Limb" (*ibid.*, 1897, p. 370); "On the Physical Characters of the Boys at King Edward's Schools, Birmingham, and at certain other Public Schools" (*Proc. Birm. Phil. Soc.*, 1892, 216); "On the Physical Characters of a Group of Birmingham Pupil Teachers" (*ibid.*, 1895, p. 97); "Note on a Roman Pottery near Mancetter" (*Proc. Soc. Antiq.*, vol. xvi., p. 404); "On the Prehistoric Implements of Warwickshire and Worcestershire" (*Birm. Arch. Soc. Proc.*, 1897); "Life in Early Britain: being an Account of the Early Inhabitants of this Island and the Memorials which they have left behind them" (London: D. Nutt, 1897).

WORK OF THE SMITHSONIAN INSTITUTION IN 1897–8.

THE report of Prof. S. P. Langley, Secretary of the Smithsonian Institution, upon the operations of the Institution for the year ending June 30, 1898, reached us a few weeks ago. It refers to the work of the U.S. National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, and the Astrophysical Observatory, all of which are under the direction of the Institution.

Map showing distribution of Correspondents of the Smithsonian International Exchange Service.

The promotion of original research has always been one of the principal functions of the Institution. Investigations in the anthropological, biological and geological divisions of science have been extensively carried on through the departments of the National Museum, and in the Bureau of American Ethnology there have also been special inquiries into Indian customs and languages. These lines of research being well represented by its bureaus, it has remained for the Institution proper to devote its energies more especially to some of the physical sciences.

Prof. Langley has carried on researches in the solar spectrum, which, by the active assistance of Mr. C. G. Abbot, have produced important results shortly to be published. He has not wholly discontinued the studies which he has made in regard to aërodromic experiments, and it is perhaps not improper that he should state that these have attracted the attention of other departments so far that during the war with Spain a commission was directed by the Secretaries of War and the Navy to inquire into them with a view of their possible utility in war.

In connection with the Hodgkins fund, several grants have been made for scientific investigations. Mr. A. Lawrence Rotch, of the Blue Hill Meteorological Observatory, Readville, Mass., has received grants for experiments with automatic kites, for determining, by means of self-recording instruments, meteorological data in atmospheric strata inaccessible except by some mechanical method of exploring the atmosphere.

A grant of 500 dollars has been made to Prof. William Hallock, of Columbia University, for an investigation having for its object the complete analysis of a particle of air under the influence of articulate sounds.

A final grant of 250 dollars has been made to Drs. Lummer and Pringsheim, of the Physical Institute of the University of Berlin. The investigation begun by them, in 1893, to determine the ratio of the specific heats, at constant pressure and volume, for air, oxygen, carbon dioxide and hydrogen has now so far progressed that the memoir submitted by Drs. Lummer and Pringsheim, noting the results already attained by them, has been published by the Institution in the Smithsonian "Contributions to Knowledge."

An additional grant has been made to Mr. E. C. C. Baly, of University College, London, to enable him to continue his research upon the decomposition of the atmosphere by electricity and upon the ozonising of mercury.

A grant of 250 dollars has been made to Prof. Arthur G. Webster, of Clark University, Worcester, Mass., for the continuation of a research on the properties of air in connection with the propagation of sound, special effort being directed to the securing of data relating to the influence of the viscosity of air on expiring or vanishing sounds. An instrument devised by Prof. Webster for use in this investigation gives the physical measure of sound, not only when constant, but when rapidly varying. It is expected that this research will furnish results of high practical value in connection with the question of the acoustics of auditoriums, and will contribute information upon points that have not heretofore been satisfactorily investigated.

The operations of the International Exchange Service continue to extend. In 1887 this branch of the Institution sent out 71 tons of documents, and had 2165 correspondents in the United States and 7396 foreign correspondents; during the year covered by the present report it transmitted 151 tons, and had 6915 correspondents at home and 22,543 abroad distributed among 93 countries.

Of the total number—29,458—of correspondents, 12,698 are libraries and 16,760 are individuals. There is no part of the Smithsonian Institution which more efficiently carries out the large purpose of its founder, to diffuse knowledge among men, and it is through this, as much as through any other branch, that its name is known throughout the world.

Appended to the report is a map of the world, a reduction of which accompanies this summary, showing the distribution of the correspondents of the Exchange Service.

NOTES.

THE Bakerian Lecture of the Royal Society will be delivered next Thursday, May 18. The subject is "The Crystalline Structure of Metals," by Prof. Ewing, F.R.S., and Mr. W. Rosenhain.

A DINNER of the Royal Institute of Public Health will be held at the Hotel Cecil on June 7 to meet Lord Lister, P.R.S., who will be presented with the Harben gold medal, and other distinguished guests, who will receive the Honorary Fellowship of the Institute.

THE Council of the Royal Geographical Society has awarded the founder's gold medal for this year to Captain Binger, who in the years 1887–89 carried out an extensive series of explorations in the vast area included in the bend of the Niger. The patron's medal has been awarded to M. Foureau for his explorations in the Sahara during the last twelve years. The Murchison award has been given to Mr. Albert Armitage for his valuable scientific observations made during the Jackson-Harmsworth Arctic expeditions; the Gill memorial to the Hon. David Carnegie for his journey across the Western Australian desert; the Cuthbert Peek grant to Dr. Nathorst for his important scientific exploration of the Spitsbergen Islands and the seas between Spitsbergen and Greenland; the Back grant to Captain Sykes for his three journeys through Persia, during which he has made important corrections and additions to the map of that country, and done much to clear up the geography of Marco Polo. These honours will be awarded at the anniversary meeting of the Society on June 5, and at the same time the American Ambassador will present to Sir John Murray the gold medal of the American Geographical Society for his contributions to scientific geography.

THE Duke of the Abruzzi has left Rome for Turin, whence he will start on his journey to the Arctic regions.

A LECTURE on "London Fog and Smoke," delivered by the Hon. F. A. Rollo Russell at the Building Trades Exhibition, is published in the *Public Health Engineer* of May 4. From the tables given it appears that during the five months November 1898 to March of the present year, London had rather less than half the amount of sunshine of inland stations, and little more than one-third of the sunshine of the stations on the south coast —all the stations with which comparison was made being within a hundred miles of the metropolis. Mr. Russell thinks that drastic measures should be taken to reduce the smoke nuisance from which London suffers. Apparatus conforming to certain stipulations are now enforced upon owners of house property by the local authorities, and there is no reason why similar rules for the public advantage should not be imposed upon builders and owners in relation to the consumption of fuel. Mr. Russell remarks in conclusion: "If any serious difficulty presents itself in bringing into practice the suggested taxes and remissions, the same principle of compulsion which is adopted for drainage, sanitary appliances, and building materials, might be put into force for the sake of atmospheric purity. There is nothing more important for the welfare of the race than good air, and we know that largely owing to the want of it, the populations of the central parts of our big towns decline and perish, unless continually recruited from the country. And thousands are ever flocking from country to town. Only by a return to the country, or by great improvements in the conditions of urban life, can the nation maintain its prosperity."

THE annual conversazione of the Society of Arts will take place at the Natural History Museum, South Kensington, on Tuesday, June 20.

NEWS has reached us of the death of Mr. Mariano de la Bárcena, director of the Central Meteorological Observatory, Mexico.

THE fourth annual congress of the South-Eastern Union of Scientific Societies will be held in the Mathematical School, Rochester, on May 25–27, under the presidency of Prof. G. S. Boulger.

ON Tuesday next, May 16, Prof. W. J. Sollas, F.R.S., will deliver the first of a course of three lectures at the Royal Institution on "Recent Advances in Geology"; and on Thursday, May 25, Prof. L. C. Miall, F.R.S., will begin a course of two lectures on "Water Weeds."

REFERRING to the recent celebration of the centenary of Spallanzani, the Rome correspondent of the *Lancet* says:—Nature study, up to its most refined developments in clinical observation and research, was largely represented at Scandiano, where the great naturalist, physiologist, and scholar, Lazzaro Spallanzani, died one hundred years ago. Prof. Todaro (Rome), Prof. Mosso (Turin), Prof. Bertolini (Bologna), Prof. Pavesi (Pavia), and many others hardly less distinguished, met to do honour to his memory and to inaugurate the *gabinetti scientifici* erected in the neighbouring Reggio Emilia to continue and commemorate his work. The Minister of Public Instruction was represented by Moleschott's successor in the Roman chair of Physiology, Prof. Luciani, whose speech at the tomb of the hero of the day was in all respects worthy of his reputation.

THE first statutory general meeting of the National Association for the Prevention of Consumption and other Forms of Tuberculosis, of which the Prince of Wales is president, was held on Thursday last. The Association has made much progress, no less than 1252 members having been enrolled. The members of the Council include Sir W. Broadbent, Sir J. Blyth, Sir G. T. Brown, Sir J. Crichton Browne, Sir J. T. Brunner, M.P., Sir A. Christison, Sir Ernest Clarke, Prof. Corfield, Sir R. G. Wyndham Herbert, Prof. McFadyean, Sir H. Maxwell, and Sir Frederick Wills. Dr. Clifford Allbutt, in moving a vote of thanks to the organising committee, said that since the last generation England had been losing the leading position which she had attained in preventive medicine, and he suggested the advisability of chairs of comparative pathology being established. Dr. Church, the president of the Royal College of Physicians, in seconding the motion, pointed out that the movement against tuberculosis was not a matter in which the medical profession alone were interested, or in which they should take a leading part.

THE short paper on "Aetheric Telegraphy" read before the Society of Arts on May 3, by Mr. W. H. Preece, C.B., F.R.S., and printed in the current number of the Society's *Journal*, constitutes an instructive statement as to what has been accomplished in wireless telegraphy by Mr. Marconi and before him, and what can be expected from it in the near future. As to the practical value of wireless telegraphy at present, Mr. Preece remarks: "There can be no question of the commercial value of the system for lightships, isolated lighthouses, shipping generally, and for naval and military purposes, but for commercial uses, such as telegraphic communication with France, the system is at present nowhere. A single cable to France could transmit 2500 words a minute without any difficulty. A single Marconi circuit could not transmit more than twenty words a minute."

IN connection with the subject of electrical signalling without intervening wires, an interesting letter by Prof. D. E. Hughes appears in the current number of the *Electrician*. Prof. Hughes describes experiments made by him in 1879, and witnessed by several distinguished Fellows of the Royal Society, on phenomena produced by ether waves, and the action of the waves on a microphonic coherer across intervening space. Electric waves as such were then unknown to science, so that Prof. Hughes apparently anticipated Hertz's brilliant discoveries. He also conducted experiments on wireless signalling on a considerable scale. In 1879, 1880, and 1888, he demonstrated to several eminent men of science his experiments upon aërial transmission of signals by means of the extra current produced from a small coil, and received upon a semi-metallic microphone, the results being heard upon a telephone in connection with the receiving microphone. The transmitter and receiver were in different rooms, about 60 feet apart, but signals were also received up to a distance of 500 yards, and an attempt was made to signal between houses a mile apart. Prof. Hughes considered that the results were produced by aërial electric waves; and it was because he was unable to demonstrate the actual existence of these waves that his investigations were never published.

A good instance of the manner in which "sea-serpent" myths originate is afforded by certain paragraphs which have recently appeared in the Australian papers. In its issue of February 23 the Melbourne *Argus* announced the discovery at Suwanaw Island, by the officer of a local steamer, of the remains of a sea-monster that had been stranded there some two months previously. The creature was said to be in such a bad condition that collecting its remains was a most trying task; but "two heads, the two backbones, and part of the ribs" were secured. It was stated that there was "but one body, which had a double spine, and two distinct heads"; while the approximate weight of the animal was estimated at not less than 70 tons, and its length fully 60 feet! In the issue of the following day the skulls were said to be about 3 feet long, and to carry a pair of tusks at the tip of the lower jaw. On March 2 the same paper published an announcement that Mr. E. Waite, of the Australian Museum, had identified the remains as those of a "Zithoid"—obviously a misprint for "Ziphioid." It would thus appear that the alleged double-headed monster of 70 tons weight and 60 feet length was based on two carcases of one of the species of Beaked Whales which are of such comparatively common occurrence on the Australian coasts, and the largest of which is not known to exceed 30 feet in length!

At the last meeting of the Anatomical Society of Great Britain and Ireland, Dr. Elliot Smith settled a point in the comparative morphology of the brain, which at one time was the subject of a heated controversy between Huxley and Owen. In 1861, it may be remembered, Owen maintained that the *calcar avis* and the calcarine fissure which causes it, were characters peculiar to the brain of man; a statement which Huxley showed to be untrue, the formations being well-marked in all Primate brains. Dr. Elliot Smith has reached the further generalisation that the *calcar avis* is a character shown by all mammalian brains, with the possible exception of the Prototherian. He identifies, and the reasons for this identification do not seem capable of refutation, the calcarine fissure of the Primate brain with the splenial fissure of the brain of other mammals. This generalisation will materially assist in homologising the Primate and Unguiculate *pallium*.

In a paper on "The Western Interior Coal-field of America," by Mr. H. Foster Bain, read at a recent meeting of the North of England Institute of Mining and Mechanical Engineers, the author refers to the estimated area of the coal-fields of the United States as being from 200,000 to 300,000 square miles. In this estimate tracts of Mesozoic as well as Carboniferous coal-bearing strata are included. The Western Interior coal-field occupies a portion of the western half of the Mississippi valley, and is the third in point of production in the United States. Its yield in 1897 was over thirteen million tons. The strata are all grouped as Carboniferous, although some of the higher portions have been regarded as Permo-Carboniferous. Correlations based on fossil evidence are said to be of doubtful value, as the common fossil of the upper strata occur well down in the lower beds. With regard to the coal-seams, all grades from semi-anthracite to free-burning non-coking coal occur, including gas-coal, cannel, and coking-coals.

The detailed petrographical description of some rock-specimens from Ceylon forms the subject of an interesting paper, by Herr Max Diersche, in the *Jahrbüch der k. k. geol. Reichsanstalt*, Bd. xlviii. Hft. 2 (Wien, 1898). The work is based on material collected by Prof. F. Zirkel during the winter of 1894, and the rock-types described include normal granulite, pyroxene-granulite, gneiss, granite, limestone, and quartzite. An interesting section is devoted to a description of the plumbago of Ragedara and its inclusions. The author remarks on the peculiar occurrence of the graphite at this locality in the form of ramifying veins of varying thickness, sharply marked off at the margins from the surrounding matrix of granulite and pyroxene-granulite. The peculiar mineral and rock inclusions which occur in the graphite veins are dealt with at length, and the paper concludes with a brief discussion of some of the theories that have been brought forward to account for the origin of the graphite. This number of the *Jahrbüch* contains also a geological description of the southern part of the Karwendel Alps, by Herrn Ampferer and Hammer. The region comprised is situated immediately to the north of the Inn valley in the neighbourhood of Innsbruck, and is one which, from its complex relations of structure and facies, offers many difficult problems for geological elucidation. But the authors, with limited time at their disposal, have dealt in a comprehensive manner with the stratigraphy and tectonic relations of this complicated area; and their paper, illustrated by numerous diagrams and accompanied by a coloured geological map, should prove of value to students of Alpine geology.

Another important contribution to our knowledge of the geology of the Alps appears in the *Verhandlungen* of the above institution (December 1898), where Dr. E. Shellwien records the discovery of a typical marine Permo-Carboniferous fauna in the neighbourhood of Neumarktl, in the Eastern Alps. This occurs at the horizon of the light *Fusulina*-limestone of the Carnic Alps, and there is evidence that in this region there has been uninterrupted deposition from the middle of the Upper Carboniferous into the Lower Permian. The author is led to regard this Permo-Carboniferous limestone as the equivalent of the Cusel beds of Germany. The fauna includes new and interesting forms, and among the Brachiopoda some remarkable types are found to occur. Besides representatives of the genera *Scacchinella* and *Meekella*, a new genus, *Tegulifera*, is present in abundance. It is characterised by a peculiar mode of growth of the larger valve, the lateral margins of which overlap the smaller valve, and, by their continued growth, ultimately envelop the latter completely. The discovery of this comparatively rich fauna corroborates in the fullest manner the views for some time held by Stache regarding the true age of the upper *Fusulina*-limestone stage in the Carnic and Julian Alps.

We have received a copy of the Second Annual Report of the Geological Commission of the Cape of Good Hope for 1897, and published in 1898. This contains a first instalment of the geological map, neatly printed in colours, and including great part of the Colony eastwards to Cape Infanta and Ladismith, and northwards to Cape Columbine and Laingsburg. The map, which is on a scale of about an inch to 12 miles, is the work of Messrs. A. W. Rogers and E. H. L. Schwarz; and it is accompanied by sections showing the flexured structure of the country. A well-deserved tribute is paid to the previous labours of Andrew Geddes Bain and E. J. Dunn. The oldest rocks, known as the Malmesbury Beds, comprise non-fossiliferous slates, mica-schists and quartzites, with intrusive granite. A great unconformity exists between these rocks and the overlying Table Mountain Sandstone. That series again is non-fossiliferous, but it is succeeded by the Bokkeveld Beds, shales and sandstones which yield genera characteristic of the Devonian period. The overlying Witteberg Beds, mainly quartzites, have yielded but a few obscure plant-remains; while still higher in the sequence comes the Dwyka Conglomerate, which may be of subaërial origin; and above it there is a series of shales and sandstones, known as the Ecca Beds, which have yielded occasional plant-remains. This great series overlying the Bokkeveld Beds is usually regarded as of Carboniferous age. Attention is given in the Report to the superficial deposits, and to the economic products of the regions examined. The work of the Survey is superintended by Prof. G. S. Corstorphine.

THE Meteorological Section of the Hydrographical Committee of St. Petersburg has published, as a supplement to vol. xix. of the *Hydrographical Journal*, a useful collection of tables referring to lighthouses and stations on the shores of the Black Sea and Sea of Azov, and of the Caspian, Baltic and White Seas. The observations were made in the years 1890–6, and give for each month and year particulars relating to the level of the water, the direction and velocity of wind, and the temperature of the sea surface. The text also contains details of the various stations, the times of observation, &c.

IN the *Verhandlungen* for 1898 of the Natural History Society for the Prussian Rhineland, &c., Dr. Geisenheyner commences an exhaustive account of the Rhenish Polypodiaceæ. The present instalment is entirely devoted to the three species *Blechnum spicant*, *Scolopendrium vulgare*, and *Ceterach officinarum*; numerous forms, varieties, and sports being described in great detail.

THE first and second Hefts of vol. xxvii. of Engler's *Botanische Jahrbücher* are chiefly devoted to instalments, by various authors, of the editor's contributions to the Flora of Africa. There are, in addition, papers by Dietel and Neger on the Uredineæ of Chile; by Pilger, on South American grasses; and by Ule, on the Sphagnaceæ of Brazil.

MR. A. H. TROW reprints from the *Annals of Botany* a paper containing an elaborate account of researches on a Welsh variety of *Achlya americana*, undertaken with the special object of determining the nature of the chromosome-like body in the centre of the nucleus. His conclusion is that the nucleus is bounded by a nuclear membrane, and possesses a central body of spongy texture, which contains chromatin and nucleolar matter, but is neither a nucleole nor a chromosome. He thinks it probable that the reducing divisions in the different groups of plants are not all homologous. There is a true homology in the Muscineæ, Vascular Cryptogams, and Spermaphytes; while in the Thallophytes there are apparently two types of reducing division which are not homologous.

WE have received (in two parts) an exhaustive account of the indigenous native drugs of Australia, by Mr. J. H. Maiden, Government Botanist, issued by the Department of Agriculture, Sydney. It would appear, from Mr. Maiden's opening remarks, that Queensland is by far the richest of the Australian Colonies in native medicinal plants; but the great majority of these are common to India and the Eastern Archipelago. In New South Wales the number of really useful native drugs is very small. In contrast to the natives of India, the Australian aborigines have but very little knowledge of the medicinal properties of their native plants. In addition to a portion of this same paper, the *Agricultural Gazette of New South Wales* for February 1897 contains also the commencement of a paper by Mr. Maiden on the native food-plants of Australia, as well as a number of others by various writers on the cultivation of fruits and other food-plants, and on the breeding of live-stock, of interest to the colonists.

As already announced, MM. Georges Carré and C. Naud have commenced the publication of a physical and a biological series of brochures, under the title of *Scientia*. The third volume of the biological series, "Les fonctions rénales," by Prof. H. Frenkel, has just been published.

Pearson's Magazine for May has an interesting article, by Sir Clements Markham, illustrated by several instructive maps, on the parts of the earth which remain to be explored. The same number contains a short account of Mr. Nikola Tesla's experiments with currents of high potential and high frequency.

THE second part of Mr. M. M. Pattison Muir's "Course of Practical Chemistry" has just been published by Messrs. Longmans, Green, and Co. The first part appeared in 1895, and a third part has yet to be published in order to complete the work. We propose to review Mr. Muir's systematic course of laboratory work when the three volumes are available.

PROF. MAURICE FITZGERALD writes to say that in his article on "The Flight of Birds," in NATURE of April 27, he inadvertently attributed to Lord Kelvin the explanation of the way in which birds may utilise varying air currents for soaring instead of to Lord Rayleigh, who published it in NATURE on April 5, 1883 (vol. xxvii. p. 534).

THE relationships between organic and inorganic chemistry were discussed by Dr. H. N. Stokes in an address recently delivered before the Chemical Society of Washington, and printed in *Science*. Incidentally Dr. Stokes remarks: "The aim of physical chemistry will have been accomplished when it has established a mathematical equation which, by proper substitution, will enable us to predict the nature of every possible chemical system or reaction, and the properties, physical and chemical, of every possible element or compound."

MR. J. G. FRAZER concludes, in the current number of *The Fortnightly Review*, a contribution commenced in the April issue on "The Origin of Totemism." The general explanation of totemism to which the *Intichiuma* ceremonies, which are described in "The Native Tribes of Central Australia," by Messrs. Spencer and Gillen, and discussed in the first part of the paper, seem to point is that it is primarily an organised and co-operative system of magic designed to secure for the members of the community, on the one hand, a plentiful supply of all the commodities of which they stand in need, and, on the other hand, immunity from all the perils and dangers to which man is exposed in his struggle with nature. Such an explanation is shown to be both simple and natural, and in entire conformity with the practical needs as well as the modes of thought of savage man. Referring to the investigations made by Messrs. Spencer and Gillen, Mr. Frazer, while admitting that it may be premature to say their work has finally solved the problem of totemism, says the researches at least point to a solution more complete and satisfactory than any that has hitherto been offered.

PROF. HERDMAN, F.R.S., with the assistance of Mr. Andrew Scott and Mr. James Johnstone, has drawn up in the form of a brochure of eighty-eight pages, the report for 1898 of the Lancashire sea-fisheries laboratory at University College, Liverpool, and the sea-fish hatchery at Piel. The report contains papers by Mr. Andrew Scott on fish-hatching work at Piel, observations on the occurrence and habits of *Leptocephalus*, observations on the habits and food of young fishes, plankton work and experiments with weighted drift and bottles. Mr. James Johnstone writes on the spawning of the mussel (*Mytilus edulis*); Prof. Herdman on sea-fish hatching, and on oysters and disease: Mr. Charles A. Kohn on occurrence of iron and copper in oysters; Mr. R. S. Ascroft on mussels and mud-banks; and Messrs. F. W. Keeble and F. W. Gamble present a brief report on the physiology of colour-change in *Hippolyte* and other marine crustacea. This is the first complete year of Mr. Scott's work at the Piel hatchery, and of Mr. Johnstone's work at the laboratory. The laboratory attached to the hatchery is open, under certain conditions, to the use of *bona-fide* students and others desirous of prosecuting research. A glance at the above list of papers will show the variety and extent of the investigations that were undertaken last year.

THE scientific activity of the Société de Physique et d'Histoire naturelle de Genève during 1898 is evidenced by the survey of papers published in the *Archives* of the Society, given by Prof. Albert Rilliet in his presidential report just issued. In mathematics and astronomy M. René de Saussure contributed the results of a geometrical study of the movement of fluids, Prof. Gautier computations referring to the return of Tempel's periodic comet, and M. Pidoux observations of an occultation of Antares by the moon. In physics and chemistry M. Dumont gave an account of researches on the magnetic properties of iron and nickel, MM. Dutoit and Friderich described a method of indirectly calculating critical pressure, Prof. Amé Pictet gave an account of further researches on the synthesis of nicotine, and Prof. Soret described his investigations of the causes which produce left- and right-handed crystals in salts active in the crystalline state and inactive in solution. Although no positive results were obtained, the work is important from a statistical point of view. Among the subjects of papers in zoology, physiology, and medicine, were the development of butterflies, by M. Arnold Pictet; and the place of origin of vaso-motor nerves, and effects of currents of high frequency upon the frog, by Dr. Batelli. In botany, a paper by Mlle. Goldfluss on the functions of certain cells was communicated by Prof. Chodat. In physical geology, M. Ed. Sarasin described the records obtained by a limnimeter established at Lucerne during five months in 1897. The records show three distinct periods of oscillation. The results of a detailed inquiry into the constitution of Mont Blanc are given by Prof. Duparc in an important memoir just published by the Society. Finally, mention may be made of a paper by MM. Etienne Ritter and Delebecque on the lakes of the Pyrenees. A number of other papers were read before the Society during 1898, but those here mentioned will be sufficient to show the valuable character of the work accomplished.

THE additions to the Zoological Society's Gardens during the past week include two Mozambique Monkeys (*Cercopithecus pygerythrus*), a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Mr. Boyd Alexander; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Herbert Peel; a Slow Loris (*Nycticebus tardigradus*) from Malacca, presented by Mr. W. H. St. Quintin; two Squirrel-like Phalangers (*Petaurus sciureus*, ♂ ♀) from Australia, presented by Mr. A. V. Willcox; four Dormouse Phalangers (*Dromicia nana*) from Tasmania, presented by Dr. McDougall; a Greater Black-backed Gull (*Larus marinus*), a Lesser Black-backed Gull (*Larus fuscus*), European, presented by the Rev. W. B. Tracy; a Drill (*Cynocephalus leucocphoeus*), a Kusimanse (*Crossarchus obscurus*), a Pardine Genet (*Genetta pardina*), a Home's Cinixys (*Cynixys homeana*), a Derbian Sternothere (*Sternothoerus derbianus*) from West Africa, a Bell's Cinixys (*Cinixys belliana*) from Tropical Africa, a Common Zebra (*Equus zebra*, ♂) from South Africa, a Grecian Ibex (*Capra oegagrus*, ♂), South-east European, a Two-wattled Cassowary (*Casuarius bicarunculatus*) from the Aroo Islands, deposited; two Larger Tree Ducks (*Dendrocygna major*) from India, purchased; a Mouflon (*Ovis musinon*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1899 *a* (SWIFT).—This comet is now well situated for observation in the early morning, and has been frequently seen during the past week. Passing rapidly to the north-west, it will rise earlier every morning, and opportunities will be afforded of obtaining both photographic and visual records of its form and spectrum. The positions predicted by the ephemeris are so nearly correct that there is no possibility of mistaking the comet. As seen on several mornings at the Solar Physics Observatory, South Kensington, it appears to the unaided eye as bright as a star of the fourth magnitude, and, though possessing no tail, is sufficiently unlike a star in appearance to attract notice. With a telescope it is seen to consist of an irregular nucleus about 1′ in diameter, surrounded by a much fainter nebulous mass some 10′ in diameter. Photographs of the spectrum have been obtained showing six bands between D and H, the origins of which have not yet been deduced.

During the week the comet will pass from Pegasus into Lacerta, through a region devoid of conspicuous stars; but on the 17th it will be about 3° west of the second magnitude star *o* Andromedæ.

The following ephemeris is by Herr H. Kreutz in *Astr. Nach.* (Bd. 149, No. 3556).

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
May 11	... 23 26 28	... +33 12·7	... 1·66
12	... 20 48	... 34 33·1	
13	... 14 41	... 35 36·8	... 1·68
14	... 8 2	... 37 23·9	
15	... 23 0 46	... 38 54·2	... 1·71
16	... 22 52 48	... 40 27·8	
17	... 44 2	... 42 4·2	... 1·74
18	... 22 34 21	... +43 42·9	

TEMPEL'S COMET (1873 II.). — The following ephemeris for this comet is by M. L. Schulhof in *Astr. Nach.* (Bd. 149, No. 3554):—

Ephemeris for 12h. Paris Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
May 11	... 19 0 46·1 ...	− 4 15 3	
12	... 2 25·8 ...	4 11 42	... 0·592
13	... 4 5·2 ...	4 8 30	
14	... 5 44·2 ...	4 5 29	
15	... 7 22·7 ...	4 2 38	
16	... 9 0·9 ...	3 59 59	... 0·673
17	... 10 38·7 ...	3 57 31	
18	... 19 12 16·1 ...	− 3 55 17	

The comet is moving slowly to the north-east, passing from Scutum Sobieski into the southern part of Aquila, being about 10° S.W. of α Aquilæ on the 18th.

A telegram just received from Kiel announces the first observation of this comet during this apparition, by Prof. Perrine at the Lick Observatory. Its position as measured was R.A. 18h. 52m. 58s., Decl. − 4° 32′ 19″ } 1899 May 6, 13h. 40·5m. Lick Mean Time, and it is described as being faint.

The close agreement of these numbers with the computed data given in the ephemeris renders any revision of the latter unnecessary.

PROGRESS IN THE IRON AND STEEL INDUSTRIES.[1]

THE announcement that Her Majesty the Queen will be graciously pleased to accept the Bessemer Medal for 1899, in commemoration of the progress made in the iron and steel industries during her reign, will be received with enthusiasm throughout the Empire. What the progress has been it will be

[1] Abstract of the presidential address to the Iron and Steel Institute, by Prof. Sir W. Roberts-Austen, K.C.B., D.C.L., F.R.S., delivered before the members of the Institute on May 4.

my privilege to indicate in this Address; for your last President of the century, in bidding it a respectful farewell, must offer the best retrospective tribute he can to the grandest industry in the world's history.

This address will, therefore, be mainly devoted to the consideration of British efforts in connection with iron and steel. I shall hope on another occasion to pay homage to the services rendered in other countries to our branch of metallurgy, but in view of our autumn meeting last year at Stockholm, I cannot proceed further without making a brief reference to Sweden. To her scientific men our debt is great and of long standing, for we have profited by their labours from the eighteenth century until now. We appreciated the interest in our proceedings which was shown by the presence of His Majesty the King and the Royal Princes at our meetings in the Riddarhus. The gracious kindness of His Majesty during the magnificent reception at his palace of Drottningholm will never be forgotten by those of us who were present. The spontaneous warmth of our reception by the Swedish people also touched us deeply, and the memories of our visit will be handed down as traditions to future members of our Institute, who, in the days to come, will, we trust, again seek the aid of Sweden by supplementing the ores of our own possessions with those from within the Arctic circle.

From the technical point of view, as the eighteenth century closed, a new era in the metallurgy of iron had already begun. Abraham Darby had successfully introduced the use of coke in the blast-furnace; James Watt had, by his powerful engines, much facilitated the production of blast, and had greatly stimulated the out-turn of pig iron. Nevertheless, the total annual production of pig iron in the year 1799 did not exceed some 150,000 tons. From the scientific point of view the situation was one of singular interest. The early writers held that good and bad qualities might be inherent in the iron itself. Pliny points out how greatly the properties of iron depend upon its treatment, but he thought that as for the kinds of iron, they were many and all were distinct, and the first difference arises from the diversity of the soil and climate where the mines are found. But Pliny's view survived far into the present century, and evidence of it lingered in the effective and graceful speech in which the Member for Merthyr proposed a vote of thanks to our first President on the delivery of his inaugural address. Mr. Fothergill said then that "thirty years ago the idea prevailed universally . . . that good iron was to be found in certain localities, and could be procured from no other place; it was found good in one place and bad in another." He adds: "Enlightened progress of the last thirty years has shown that the quality of iron depends upon the alloy with which it is mixed."

Enduring as the old view as to the influence of locality was, an experimental basis for a more accurate one had been established very shortly before the present century began, and some, at least, knew that the properties of iron depended on the presence or absence of certain other elements. This position was clearly established by the great Swedish chemist, Bergman of Upsala, who had shown that carbon is the element to which steel and cast iron owe their distinctive properties. He had initiated the employment of calorimetric methods in determining the properties of iron and steel. He insisted that the real difficulty is to explain how it is that the presence of 0·5 per cent. of carbon in iron enables the metal to be hardened by quenching from a red heat, or, in his own expressive words, *Ceterum quomodo dimidia centesima, plumbaginem efficiens, tantam provocare possit differentiam, nodus est gordius haud facile solvendus.* Bergman, moreover, anticipated the later phases of modern research by claiming that iron is a polymorphic element, and plays the part of many metals. In this early view as to the allotropy of iron it should be remembered that in 1790 our countryman, James Keir, followed him closely by urging, before the Royal Society, that what we now call passive iron "is really a distinct form of iron, the alteration being produced without the least diminution of its metallic splendour or change of colour."

Clouet's celebrated experiment on the carburisation of iron by the diamond followed. Doubts, however, were not finally set at rest until 1815, when Pepys, a working cutler in London, excluded the possibility of the intervention of furnace gas. But, as soon as the present century had well turned, the industrial world was in possession of the fundamental fact that carbon is the element of dominant importance in relation to the metallurgy of iron. Well might Bergman express astonishment at the action of carbon on iron. Startling as the statement may seem, the destinies of England throughout the century, and especially during the latter half of it, have been mainly influenced by the use of steel. Her steel rails seldom contain more than Bergman's half per cent. of carbon. Her ship-plates, on which her strength as a maritime power depends, contain less than half that amount. It is essential that the significance of this fact should be clearly understood. Our national existence has long depended on iron and steel. They have been the source of our wealth, one of the main elements of our strength, one cause of our maritime supremacy. Hardly a step of our progress or an incident of our civilisation has not, in one way or another, been influenced by the properties of iron or steel. It is remarkable that these properties have been determined by the relations subsisting between a mass of iron, itself protean in its nature, and the few tenths per cent. of carbon it contains. These properties are, it is true, modified either by the simultaneous presence of elements other than carbon, or by the thermal or mechanical treatment of the mass. The growth of our knowledge of the facts constitutes a large section of our scientific and industrial history. The question arises—Was our national progress delayed by the unreadiness of the technical world in England to take advantage of the facts that science had established?

If we consider the position from the point of view of two remarkable men who were looking for the dawn of the nineteenth century as we are for that of the twentieth, we shall, I think, be satisfied that our progress received no check from failure of industrial workers to assimilate the teaching of science. These men were Black and Cort. Of the scientific men then living, the greatest chemist was Black, Professor at the University of Edinburgh, whom Lavoisier had generously acknowledged as his master. Black fully recognised the importance of Bergman's work, and on his own part insisted on the importance of what would now be called the change in molecular energy as the physical basis on which the properties of iron and steel depend. Black, moreover, in his public lectures gave a singularly accurate description of the process of decarburising iron called "puddling," and devised by "a Mr. Cort," with the results of whose work Black was soon to become familiar. Considering how recent the knowledge of the meaning of oxidation really was at the time, Black's statements with regard to the theory of puddling are truly remarkable. Later on he furnished the Government with an elaborate report on the quality of the material obtained by puddling. He showed, by such mechanical tests as the experience of the time suggested, the superiority of puddled iron, and pointed out that it was more suitable than foreign iron for the appliances "on which," as he says, "the lives of our seamen and the safety of our ships have hitherto mainly depended."

At the end of the century we are justly proud of our colonial possessions, and are satisfied that the varied applications of iron and steel will enable us to knit together all parts of the empire. At the beginning of the century, Lord Sheffield, in his "Observations on the commerce of the American States," writing in the early days of Cort's process, shows that it would help to make British iron as cheap as the foreign, an event which he considered would be more advantageous to England than the possession of her American colonies. Black died in 1799, Cort survived till 1800, so that as the eighteenth century closed, the most eminent scientific man and the foremost practical metallurgist of the generation stood side by side. To Cort we owe the greatest technical advance the modern world had seen; to Black the recognition of the importance of molecular energy in relation to metallurgical problems.

The production of pig iron in this country also received a great stimulus from the discovery by Mushet about the year 1800, that the large deposits of blackband ironstone could be utilised. The century opened with, in round numbers, an annual production of pig iron not exceeding 200,000 tons, of which less than one-third was converted into bars and other descriptions of wrought iron. The capital invested was under five millions, and employment was furnished for nearly 200,000 people.

Returning to the scientific aspect disclosed at the dawn of the century, the year 1803 was an eventful one for science. Nevertheless, the impulse given to research was not in the most favourable direction for the advancement of metallurgic art. The influence of a small proportion of carbon on iron had been recognised, but the quantitative relation between the iron and the carbon was only considered as bearing on the nature of the product, and not at all from the point of view of chemical union. When, therefore, in 1803, Claude Louis Berthollet published his "Essai de Statique Chimique," it appeared that the action, of what for the moment I may be permitted to classify as the action of *traces* upon *masses*, was in a fair way to be elucidated for the following reason. Berthollet pointed out that "in comparing the action of bodies on each other which depends on their affinities and mutual proportions, the influence of mass has to be considered." Unfortunately in succeeding years the views of Prout, the courteous opponent of Berthollet, prevailed, mainly through the powerful aid of Dalton, who published also in 1803 his first table of atomic weights. Hence the phenomena which could not be attributed to fixed atomic proportions were set aside and usually neglected. Evidently the action of one-tenth per cent. of carbon on iron could not be explained by the aid of combining weights. The century was more than half over before a school of eminent chemists arose, who did not insist that matter is minutely granular, but in all cases of change of state made calculations on the basis of work done, viewing internal energy as a quantity which should reappear when the system returns to its initial state.

The production of cast iron and bar iron was rapidly increasing, and the suitability of cast iron and bar iron for the construction of bridges became evident to engineers, among whom Telford was pre-eminent. A distinguished professor, a worker in pure science, came, in the person of Dr. Thomas Young, to the aid of the technical worker. The need of studying the mechanical properties of iron and steel was evident, and Young showed that the work done in permanently extending or in compressing iron or steel could be represented by a coefficient, to which he gave the name of the "Modulus of Elasticity." This coefficient has probably rendered more service in the development of the study of the strength of iron and steel than any other which has been determined. It is of great importance, because upon it depends the deflection which a structure will take under strain. Young, evidently with a view to bring home evidence as to the great rigidity of steel, gives in his original paper a quaint illustration. He therein shows that if "Hook's law holds" a hanging rod of steel would have to be 1500 miles long in order that the upper portions of it might be stretched to twice their original length. I would incidentally point out that on the basis of Young's calculation, such a column 1500 miles high, if it were 1 foot $2\frac{4}{10}$ inches in diameter, would represent the output for the past year of Bessemer steel in this country alone. Statements of this kind had such a singular fascination for Sir Henry, that I have permitted myself a brief departure from chronological order in offering this one.

[The President then referred to the patent granted in 1817 to the Rev. Robert Sterling for the "regenerative furnace," and to the work of S. B. Rogers, who introduced "iron bottoms" in the puddling furnace. An interesting fact was mentioned which justified the claim made in the address, that Rogers was the pioneer of the great process afterwards known as the "basic" process of dephosphorisation. Faraday's work on alloys in 1820, and his discovery of "a carburet of iron" in 1822 was then described, and the merits of Neilson's discovery of the "hot blast" in 1828 were fully dealt with. After a brief reference to the work of Thomas Andrews, of Belfast, on the "heat of combination," the President proceeded to review the theories of the action of the blast-furnace, and especially referred to the work done in the year 1846.]

It was pointed out in 1846 that in the blast-furnace there was evidently a kind of tidal ebb and flow in the relations of carbon and of oxygen, resulting sometimes in reduction, and at others in oxidation or carburisation; but the changes were all capable of more or less simple expression if viewed either from the atomic or the dynamic standpoint. As the furnaces grew in dimensions, their flaming tops threw a lurid glare over the country, and, "like the dying sunset kindled through a cleft," revealed the magnitude of the problems involved in blast-furnace practice, which were seen to be disproportionate to their apparent simplicity.

In the first half of the century efforts were directed mainly to obtaining a material—cast iron containing some $3\frac{1}{2}$ per cent. of carbon, and fusible at a temperature readily attained in the blast-furnace. In the second half of the century, while efforts to obtain this fusible material were increased, attention was also directed to removing the carbon, and obtaining a product which had a melting point of 400° C. (720° F.) higher than cast iron. This product was either cast directly into ingot moulds or recarburised to the extent necessary to constitute the various gradations of steel. Sheffield hardly knew steel except as a material to be used for the manufacture of cutlery, for which she had been famous since the time of Chaucer.

It is characteristic of our British methods that special circumstances and needs, mainly arising in connection with the development of the steam engine and railways, revealed the broad principles by which the production of iron must be governed. It was natural, therefore, as time went on, that in the work of successive inventors the guidance of scientific principles became progressively evident as ill-directed efforts were gradually replaced by the results of systematic experiments.

The second half of the century began with events of strange importance. The Great Exhibition revealed our industrial strength to all nations. The official reporter of the metallurgical group states that 2,250,000 tons of pig iron were annually produced in this country, and that its estimated value was 5,400,000*l.* The annual production had risen in fifty years from two hundred thousand tons to over two and a quarter millions. Sheffield produced at the opening of the century 35,000 tons of steel, of which 18,000 tons were cast steel. Messrs. Turton exhibited a single ingot of steel weighing 2688 lbs., but Krupp showed an ingot of double the weight, for our country was only preparing for the great change which was so soon to enable it to lead the steel manufacture of the world.

A noteworthy feature of the Exhibition was the collection of iron ores of this country exhibited by Mr. Blackwell, who subsequently, and most generously, provided funds for their analysis. With reference to this collection, the reporter points out that in this country "the ores are not carried far, except where there is great facility for transport." This is noteworthy, as before the century was much older an important supply of ore was brought from Spain, and in the near future we may even seek a supply for British furnaces from distant parts of our own empire.

The year 1851 was, moreover, an important one for metallurgy in this country, as it saw, by the wisdom of H.R.H. the Prince Consort, the establishment of the institution which developed into the Royal School of Mines. If the projected scheme of instruction had been fully carried out, the establishment of a general system of technical instruction, which the pressure of necessity is slowly forcing upon us, would have been anticipated by forty years.

The year 1856 will be ever memorable in the metallurgical annals of our nation as that in which Bessemer gave the description of his process to the world at the Cheltenham meeting of the British Association. As regards the process itself, we have too lately lost our great countryman, and many of us are too familiar with the details of his labours to be able either to fully estimate its value or to realise the wonder of its results. Let us try to think of the Bessemer process as I believe those at the end of the twentieth century will, whose views range over a wider perspective than we can command. The economic aspect of the question will naturally strike the metallurgists of the twentieth century. They will see that in 1855 the make of steel in Great Britain did not exceed 50,000 tons, and the cost of the steel produced sometimes reached 75*l.* a ton. They will see that thirty years after the publication of Bessemer's paper the production of Bessemer steel rose to 1,570,000 tons, and that ship plates were sold at 6*l.* 10s. a ton. It will be noted that before the century closed, the maximum production of Bessemer steel in this country in one year reached 2,140,000 tons. The scientific aspect of the process will, however, excite their widespread interest, for before the end of the twentieth century, metallurgy will be taught in our older universities. It will be seen that, notwithstanding the title of Bessemer's Cheltenham paper, he recognised and insisted on the fact that the intense heat was engendered by the combustion of the elements within the fluid bath. It will be noted in what close relation the purely scientific work of Thomas Andrews of Belfast, on the heat of combination, stands to that of Bessemer, and that another instance is presented of the dependence of industrial work on pure investigation. Bessemer's proposal to employ a mixture of steam and air will not be ridiculed as it has been, for speculation will be rife as to whether he did not hope that the liberated hydrogen might remove sulphur and phosphorus, notwithstanding the feebly exothermic result of the ensuing combination, and in spite of the cooling effect of water vapour. In view of the fact that endothermic combinations take place at a high temperature, the possible action of hydrogen as a decarburiser will be dwelt upon. Prof. Noel Hartley's papers upon the thermo-chemistry of the Bessemer process will be read with much interest, Surprise will, however, be widely felt that physicists generally of the last half of the nineteenth century did not see in the lovely flames of lilac, amethyst, gold, and russet, or in the "stars suspended in a flying sphere of turbulent light" which come from the converter, an appeal to fully investigate their cause and to study the dynamic problems presented by the intense heat engendered. Why was not the destination ascertained of the 1000 cubic feet of argon which accompanies the air passing through the metal during an ordinary Bessemer 10-ton blow? Why were not more strenuous efforts made to ascertain the effect of the temperature of the bath on the nature of the metal?

It will be felt that, as the eighteenth century had closed with a clear statement as to the true nature of oxidation, the nineteenth century had seen its magnificent application in the Bessemer process.

As regards the work of Mushet, future generations will, I believe, desire to add nothing to the words of the President of this Institution who, in 1875, had the pleasure of awarding the Bessemer Medal to him. Mr. Menelaus then said "that the application of spiegeleisen . . . was one of the most elegant as it certainly was one of the most useful inventions ever made in the whole history of metallurgy."

Attention must now be directed to the great process for the production of steel which involved the use of the "open hearth."

Sir William Siemens' life was one long and ultimately brilliantly successful effort to apply the kinetic theory of gases and the dynamical theory of heat to industrial practice. He was eminently a practical worker; but the depth and accuracy of his scientific knowledge gives him a place near that of all the great atomists from the time of Lucretius to that of our own countrymen, Graham, Joule, Clerk Maxwell, and Kelvin. In many of Siemens' papers, theory and practice are closely blended. In viewing the results of his labours, it will be seen in future ages that confidence in the trustworthy character of steel was finally established by experiments on metal produced in the regenerative furnace of Siemens. Looking back, it is astonishing with what difficulties the use of steel for structural purposes was beset. In 1859 Sir John Hawkshaw was not permitted by the regulations of the Board of Trade to employ steel in the construction of the Charing Cross bridge. Time will not permit me to indicate the efforts which were made to induce the Board of Trade to remove the serious hindrances to the use of steel, which had "rendered the construction of the projected bridge over the Firth of Forth practically impossible." These efforts were not successful until 1877, when a committee, consisting of Sir John Hawkshaw, Colonel Yolland, and Mr. W. H. Barlow, were able to recommend that the employment of steel in engineering structures should be authorised by the Board of Trade. The steel employed was to be "cast steel, or steel made by some process of fusion, subsequently rolled or hammered"; one condition of such recommendation being that "the greatest load which can be brought upon the bridge or structure, added to the weight of the superstructure, should not produce a greater strain in any part than 6½ tons per square inch."

As regards the use of steel for shipbuilding purposes, in the year 1875 Sir Nathaniel Barnaby asked, "What are our prospects of obtaining a material which we can use without such delicate manipulation, and so much fear and trembling?" He partly answered his own question four years later, when he quoted experimental evidence as to "the recent successes" of open-hearth steel. In 1890 he completed the case by pointing out that naval architects now "have a perfectly regular material, stronger and more ductile" than iron, and he speaks of "our lasting debt of gratitude for the birth and training of that true prince, William Siemens." It is hardly necessary to point out that the country owes the excellent materials used in naval architecture mainly to the productions of the regenerative furnace.

In connection with the production of mild steel, the addition of ferro-manganese to the decarburised bath proved to be most effective. We can hardly over-estimate our indebtedness to those whose perseverance ensured the adoption of mild steel for maritime and other purposes. "Looked at from the standpoint of to-day, when thousands of tons of such steel are made weekly without serious anxiety or trouble, it is scarcely possible to realise the anxieties and difficulties of the days when the manufacture of open-hearth steel was being perfected." To no one is our debt greater than to our Vice-President, Mr. James Riley, who bore a large share of the anxieties of the early days, and whose words are those I have just quoted.

With regard to the great modifications which have been effected in the Bessemer and open-hearth processes, reference must be made to that ample source of information, our *Journal*. It must also be consulted for the history of the appliances for heating the blast, with which the names of Cowper and of Whitwell will always be specially connected.

In speaking of Bessemer and Siemens I have been obliged to depart somewhat from strict chronological order. I must now resume it.

In the year 1866 Graham's first paper on the occlusion of gases by metals was published in the *Philosophical Transactions*. Its results have been far-reaching, and will always be ranged with the metallurgical triumphs of the century.

In the year 1869 our Institute was founded. In view of certain aspects of the treatment which inventors had previously received from their industrial brethren and from the country, it will be evident that the time for its formation had fully come. Taking instances almost at random, I may remind you that Dud Dudley was, as he says, "with lawsuits and riots wearied and disabled" in the seventeenth century, and that Henry Cort was neglected and oppressed in the eighteenth. The great invention of iron bottoms in the puddling-furnace made by Rogers was received with ridicule, and he died in poverty. Popular tradition of Sheffield indicates that possession was obtained of Huntsman's secret "by the heartless trick of a rival." Neilson, though he warmly acknowledges the support he received from certain ironmasters, was treated with singular meanness by others. Heath fought single-handed for fifteen years "against a common purse, the accumulation of the wealth which he had created." Even Bessemer's early statements were received with incredulity and contempt. With the formation of our Institute all this is changed: men place the results of their work and experience freely at the disposal of their brethren, and each fresh advance meets with appreciative consideration. "Vigorous moderateness," wrote the late Walter Bagehot, "is the rule of a polity which works by discussion. . . . It was government by discussion that broke the bond of ages and set free the originality of mankind."

[It was then pointed out, that the history of the iron and steel industry since the formation of this Institute was epitomised by the labours of those who had occupied the presidential chair. The President, therefore, gave a brief sketch of the work done either by the successive Presidents of the Institute, or during their respective terms of office.]

The address then continues as follows: This concludes the list of those who have hitherto presided over the Institute, and it will have been evident that from time to time other interests than those connected with iron and steel have been represented by your Presidents. We were reminded of this fact when the Institute first met, now twenty-four years ago, at Manchester, where we are promised a delightful meeting again next autumn. The Bishop of that great city then welcomed us by a quotation from Virgil, which connects the age of iron with the age of gold. The passage runs thus:—

"quo ferrea primum
Desinet ac toto surget gens aurea mundo."

A President of this Institute who has had the privilege to serve in the Mint, in a sense connects the iron and the golden age. I find that during the course of a long official career I have been responsible for the standard fineness of over one hundred and twenty-one millions of gold coin. This sum is so vast, and the anxiety connected with it has been at times so great, that I am not careful to conceal the pride revealed by this reference to it, as it is an exponent of the financial greatness of the nation which created the age of steel. But I value as highly the means of conducting research and the hope of being useful, which was also given me by the Government when I was appointed Professor of Metallurgy at the Royal School of Mines. I have in the discharge of my duties persistently striven to show that what is called applied science is nothing but the application of pure science to particular classes of problems.

I regret that space will not permit me to consider the progress of the century as measured by the work of our Bessemer medallists. I hope, however, as regards the labours of the foreign recipients of the honour, to deal with them next spring.

The metallurgy of America is so closely interwoven with our own, that I must permit myself a brief reference to four men who stand out from the industrial ranks of our kinsmen. These are Alexander Lyman Holley, the Hon. Abram S. Hewitt, John Fritz, and Prof. Henry Marion Howe. All of them are Bessemer medallists.

It may help us to estimate the value of the labours of the four men whose names I have given if we remember that at the present time the United States export about a million tons of iron and steel a year, while twenty years ago they were not exporting any. We may also fairly consider their influence on the rapid development of the United States Navy. It would seem that we, in this country, in the belief in our insular security, had somewhat neglected the art of naval warfare, until Admiral Mahan reminded us of what we had done in the past, and of our possible course in the future, in a series of writings which have done much to convince the two nations, England and America, "that they are in many ways one."

It is time to offer a collective statement of the achievements which have either been actually effected or are in immediate prospect.

There are blast-furnaces which will produce 748 tons of pig iron in twenty-four hours, with a consumption of little over 15·4 cwts. of coke per ton of iron. The gases from blast-furnaces are used, not only as sources of heat, but directly in gas-engines.

There are Bessemer converters which can hold 50 tons of metal, and open-hearth furnaces which will also take 50 tons, while 100-ton furnaces are projected. The open-hearth furnaces are fed with one ton of material in a minute, by the aid of a large spoon worked by an electro-motor. There are gigantic "mixers," capable of holding 200 tons of pig iron, in which, moreover, a certain amount of preliminary purification is effected.

Steel plates are rolled of over 300 feet in area and 2 inches thick. There are girders which justify the belief of Sir Benjamin Baker that a bridge connecting England and France could be built over the Channel in half-mile spans. There are ship-plates which buckle up during a collision, but remain water-tight.

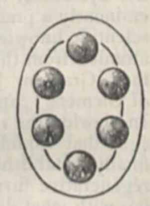
There are steel armour piercing shot which will penetrate a thickness of steel equivalent to over 37 inches of wrought iron. The points of the shot remain intact, although the striking velocities are nearly 2800 feet a second. There are wires which will sustain a load of 170 tons per square inch without fracture. Hadfield, whose labours will, I trust, be continued far into the twentieth century, has given us manganese-steel that will not soften by annealing; while Guillaume has studied the properties of certain nickel steels that will not expand by heat, and others that contract when heated and expand when cool. Nickel, chromium, titanium, and tungsten are freely used alloyed with iron, and the use of vanadium, uranium, molybdenum, and even glucinium, is suggested. There are steel rails which will remain in use seventeen years, and only lose 5 lbs. per yard, though fifty and a half million tons of traffic have passed over them.

Huge ingots are placed in soaking pits and forged direct by 120-ton hammers, or pressed into shape by 14,000-ton presses. With such machinery the name of our late Member of Council, Benjamin Walker, will always be connected.

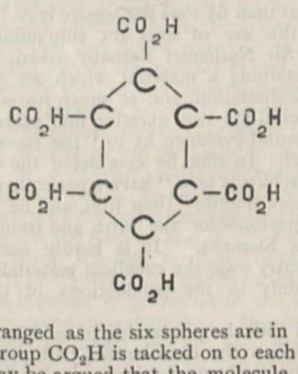
There are steel castings, for parts of ships, that weigh over 35 tons. We electrically rivet and electrically anneal hardened ship-plates that could not otherwise be drilled. Photomicrography, originated by Sorby in 1864, now enables us to study the pathology of steel, and to suggest remedial measures for its treatment. Stead's work in this field is already recognised as classical. Ewing and Rosenhain have, in a beautiful research recognised quite recently by its aid that the plasticity of a' metal is due to "slip" along the cleavage planes of crystals. Osmond also by its aid shows that the entire structure of certain alloys may be changed by heating to so low a temperature as 225° C.

Passing to questions bearing upon molecular activity, we are still confronted with the marvel that a few tenths per cent. of carbon is the main factor in determining the properties of steel. We are, therefore, still repeating the question, "How does the carbon act?" which was raised by Bergman at the end of the eighteenth century. Nevertheless, from the molecular point of view, much may be said in answer to the question. The mystery is in fact lessened now, as it is known that the mode of existence of carbon in iron follows the laws of ordinary saline solutions. Our knowledge is, however, of very recent origin, and we owe mainly to the Alloys Research Committee of the Institution of Mechanical Engineers the development of Matthiessen's view that there is absolute parallelism of the solution of salt in water and carbon in iron.

An ice-floe in a Polar sea contains a small percentage of salt; a red-hot ingot of mild steel holds some two-tenths per cent. of carbon, but both the carbon and the salt are in the state of *solid* solution. If the ice had been cooled below − 18° C., it would entangle a solidified portion of salt water, which was the last part of the mass to remain fluid. So in the steel ingot, when it has cooled to the ordinary temperature, there is a solidified "mother liquor" of carburised iron. We do not as yet know whether carbon is dissolved in fluid iron as carbon or as a carbide. We do know, however, that the presence of 0·5 per cent. of carbon in iron (such an amount as might occur in a steel rail) lowers the melting point of the iron from 1600° C. to 1530° C. This lowering has enabled a calculation to be made, the result of which shows that the number of atoms in a molecule of carbon in *fluid* iron at this temperature is probably *two*. It can be shown that at a temperature of 800° C. the number of atoms in the molecule of carbon dissolved in *solid* iron is, in all probability, *three*. At lower temperatures, the number of atoms is probably more than three. We metallurgists are not accustomed to think in atoms. Let me, therefore, represent such a three-atom molecule thus,  without assuming how much iron is associated with the carbon. Following Bergman's experimental method, but with the interval of more than a century separating his work from ours, we investigate the action of acids on carburised iron with a view to ascertain the nature of the atomic grouping of the carbon.



In explaining this, I may adopt the appended figure. It is most difficult even to attempt to make questions of atomic grouping clear in a paragraph, but the figure will be helpful. To the historian it suggests vivid pages of Italian history, as the six spheres so arranged constitute the arms of the powerful family of Medici. To the chemist it is a precious symbol, and appeals to him as representing the carbon atoms as grouped in the benzene ring. The result of treating carburised iron with various acids is the formation of marsh-gas and more complicated organic compounds, of which propylene, acetylene, ethylene, and naphtha may be mentioned. Does the nature of these products help us to ascertain the number of the atoms in the carbon molecule as it exists in cold steel? I have consulted organic chemists, among whom I would specially mention my colleague Dr. Wynne, and their evidence is encouraging. The result of the action of powerful oxidising agents on certain forms of carbon is mellitic acid, $C_6(CO_2H)_6$, which is one of the benzene series, and this favours the view that solid carbon contains twelve, or some multiple of twelve, atoms in the molecule. But mellitic acid is graphically represented in the annexed diagram, the carbon



atoms being arranged as the six spheres are in the arms of the Medici. The group CO_2H is tacked on to each carbon sphere. From this it may be argued that the molecule of solid carbon consists or one or more carbon "rings." In cold steel, the group of CO_2H may be replaced by the group Fe_3, which is broken off by the action of suitable solvents leaving free carbon. Hence the six-atom carbon molecule may exist in steel.

My object is merely to show you how far at the end of the century we have advanced in our knowledge of the mode of action of carbon, and I trust it will be evident that the progress is remarkable. We know that even in solid iron the carbon atom must push and thrust with great vigour, for we can measure the "osmotic pressure" the carbon atom exerts, and, as has just been shown, we can even picture the mode of the atomic grouping in the molecule.

I can only just sum up the evidence as to the occurrence of molecular change in iron. To Gore, and to Barrett, we owe the investigation of the nature of a fact which had long been well known to smiths, that iron on cooling from a bright red heat suddenly emits a glow. We now know that as steel cools down there may be at least six points at which molecular change occurs, accompanied by evolution of heat.

In a series of classical papers of which we are justly proud, for many of them have been communicated to this Institute, our member, Osmond, has shown what is the significance of some of these points, and has won an enduring reputation. We measure and record them photographically as readily as if they were barometric variations. It is known that three points occur in the purest electro-iron yet prepared. Two points are connected with the magnetic permeability of iron. One point at least is due to the power iron has of dissolving carbon. In some cases, two points occur far below a red heat, and appear to be due to the presence of hydrogen. Moreover, the molecular condition of steel cooled from an intense white heat is not the same as that of steel which has just been melted. To carry further the evidence as to the effect of an intense heat on iron in a vacuum is the task I have in prospect during my presidency of the Institute. I may, however, express my agreement with Lockyer's view that the evidence afforded by the atmosphere of the stars shows that our terrestrial iron is a very complex form of matter.

We must not lose sight of those relations of carbon and iron which involve physical equilibrium. Even the astonishing associations of iron and carbonic oxide in the volatile gaseous compound with which the distinguished name of Mond is connected affords a triumph of dynamic chemistry. It is generally supposed that ozone is dissociated at 160° C., but Dewar has devised a beautiful experiment to prove that ozone has two centres of stability, and one of these is near the melting point of platinum. It seems to be the same with the relation of hydrogen and iron. We have recently learned that iron and hydrogen appear to be completely dissociated at 800° C., and yet the same iron heated to some higher temperature, say 1200° C., will still yield hydrogen.

Let us suppose that Black, Cort, and Bergman were with us again, and had reviewed the present state of our knowledge and the work accomplished in the century. Let us also suppose that they could go to Sheffield and see an armour-plate rolled and finished for service, and then, visiting our Institute, hear the best explanation we could offer of all the incidental phenomena they had witnessed. Which would they consider the more advanced, our practice or our theory? They would probably hesitate to tell us, but would offer warm congratulations on the immediate prospect of the establishment of a National Physical Laboratory, in which investigations as to the properties of iron and steel will be continued.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held on May 4 and 5 at the Institution of Civil Engineers. The chair was occupied at the beginning of the proceedings by Mr. E. P. Martin, the retiring president. The report of the Council was read by the secretary, Mr. Bennett Brough, and showed that during the year 98 new members had been elected, and that the Institute had maintained its prosperous and satisfactory condition. Sir William Roberts-Austen then took the presidential chair, and delivered an inaugural address, which is printed in an abridged form in another part of this issue. A vote of thanks to the president for his address was proposed by Sir Bernhard Samuelson, seconded by Sir William H. White, and carried by acclamation.

The first paper read was by Mr. H. Bauerman on the Gellivare iron mines, the important mineral region situated in 67° 11′ North latitude and 20° 11′ East longitude. The paper gave a detailed geological description of the mineral deposits, and formed a valuable supplement to previous descriptions of these mines. In the discussion which followed, Mr. W. Whitwell pointed out the importance of this Swedish source of supply in view of the approaching exhaustion of the Spanish deposits, and Mr. H. G. Turner remarked on the similarity of some extensive magnetite deposits in Southern India.

Mr. A. P. Head read a paper on tilting open-hearth furnaces which are coming into use in the United States, and present a substantial advance in metallurgy likely to have far-reaching effects in the future of the relative positions of the Bessemer and open-hearth processes. An interesting discussion followed, in which Mr. Wellman, of Chicago, and Mr. R. M. Daelen, of Düsseldorf, took part.

Prof. Henry Louis then described a dipping needle he had devised for use in exploring for iron ore deposits, which presented decided advantages over the instruments described by Mr. B. H. Brough in 1887, and by Prof. Nordenström last year.

A paper by Prof. J. Wiborgh, of Stockholm, on the use of hot blast in the Bessemer process, was then taken as read. In this the author urged the advantages that would be derived from the use of the hot blast for small converters and for the basic Bessemer process.

The meeting then adjourned until May 5, when a paper by Prof. J. O. Arnold and Mr. A. McWilliam on the diffusion of elements in iron was read. An animated discussion followed, in which Mr. Stead, Mr. Hadfield, Mr. Harbord, Dr. Stansfield and Prof. Louis took part.

A voluminous paper by Baron Jüptner von Jonstorff, on the solution theory of iron, was taken as read. In two previous communications he sought to apply the laws of solution to iron and steel, and in this third paper he carries the research further. He finds that carbon is dissolved as such in pure iron by a sufficiently high temperature. The molecule of the dissolved carbon between 1600° and 1300° C. consists of two atoms. It increases with decreasing temperature, and at 1150° C. nearly equal amounts of two and three atom molecules are present in the solution. At a still lower temperature, there is in the solution, besides a certain amount of free carbon increasing with the content of carbon present, iron carbide. At first the latter remains in solution with the free carbon (austenite). If, however, its quantity increases above a certain amount, the alloy separates into two parts. In the one the free carbon prevails, in the other the carbide of iron (martensite) prevails. With falling temperature, the amount of the iron carbide increases, as also does the martensite, whilst the quantity of the austenite decreases until at length only martensite is present.

Mr. Enrique Disdier contributed a paper on the use of blast-furnace and coke-oven gases, in which he urged that coke-oven gases should be heated by blast-furnace gases and the oven gases used for driving gas engines. By the adoption of this method of utilising the gases, the cost of pig-iron would, he asserts, be reduced by 5*s.* 5½*d.* per ton. In the discussion, Mr. James Riley expressed the opinion that the author had worked out his case well, but considerable difficulties would have to be surmounted before his theory was put into practice. Mr. Hugh Savage described the progress that had been made in Belgium in the use of blast-furnace gases as motive power. Mr. Charles Wood and Mr. Enoch James anticipated difficulty from the dust in the gases.

Mr. Bertrand S. Summers, of Chicago, contributed a lengthy paper on theories and facts relating to cast-iron and steel. In the discussion, Mr. R. A. Hadfield expressed the opinion that there was a demand among electricians for material of high permeability and of low cost, and he thought that the author had done much to render this possible. Mr. W. Mordy also discussed the paper from the electrician's point of view.

The last paper on the list was from the pen of the great Russian metallurgist, Mr. D. Tschernoff. It described a construction of blast-furnace in which gas is used in lieu of solid fuel, and in which iron or steel may be produced direct from the ore.

The usual votes of thanks were carried, and the meeting, which throughout was largely attended and most successful, was declared at an end. On the evening of May 4, the annual dinner was held at the Hotel Cecil, and on May 5 the members were entertained by Sir William and Lady Roberts-Austen at their residence in the Royal Mint.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE first of the two soirées held annually at the Royal Society took place on Wednesday, May 3. There was a large collection of apparatus and many interesting exhibits, but our space only permits us to refer to some of those which attracted most general attention ; these are as follows :—

Mr. Thomas Andrews, F.R.S., exhibited microscopic structure of heavy steel guns, projectiles, and warship propellor shafts.

The Tsetze Fly Committee of the Royal Society showed enlarged photographs, taken by Surgeon-Major Bruce, illustrating districts in South Africa affected by the Tsetze Fly Disease.

Mr. A. Mallock exhibited thin films used as mirrors. The films are formed by allowing a solution of pyroxyline in amyl acetate to spread on the surface of water. The films being removed when the solvent has evaporated, are then stretched over rings, whose edges have been ground to a true plane, and silvered.

Dr. Patrick Manson and Surgeon-Major Ross exhibited the development of *Filaria nocturna*, Manson, and of *Proteosoma grassii*, Labbé (one of the parasites of malaria of birds), in the mosquito.

Prof. W. N. Hartley, F.R.S., and Prof. J. J. Dobbie exhibited photographs of absorption spectra of organic compounds, showing the method of investigating peculiar cases of isomerism called tautomerism or desmotropy.

Mr. Edwin Edser showed the phase-change associated with the reflection of light from a fuchsine film. Two unsilvered glass plates, forming the end mirrors of a Michelson interferometer, are provided with films of fuchsine on their back surfaces. A horizontal strip of fuchsine is removed from one of the mirrors. Interference fringes are produced by means of rays of light reflected from the fuchsine films ; these fringes are focussed on the slit of a spectroscope. The resulting spectrum is found to be crossed by vertical dark bands. In the violet and blue, the bands formed by reflection, in the glass, from fuchsine and air respectively, are seen to be continuous. Since fuchsine is optically less dense than glass for blue light, this is in agreement with theory. Passing onward toward the red end of the spectrum, a gradual displacement occurs in the bands produced by the light reflected from the fuchsine. Red light is seen to be retarded by half a wave-length when reflected from fuchsine.

Mr. Shelford Bidwell, F.R.S., exhibited experiments demonstrating multiple vision ; Mr. James Swinburne, Nernst electric lamps ; Dr. Woodward, F.R.S., a selection of zoological specimens from Christmas Island (Indian Ocean), collected by Mr. C. W. Andrews ; Dr. Francisco P. Moreno, Director of the La Plata Museum, Argentine Republic, portion of skin of an extinct ground-sloth, named *Neomylodon listai* by Ameghino, from a cavern in Southern Patagonia ; and Dr. G. Herbert Fowler, examples of floating organisms from the surface and deep water of the Faeroe Channel.

Sir W. Crookes, F.R.S., exhibited new photographic researches on phosphorescent spectra. It has long been known that certain substances enclosed in a vacuous glass bulb phosphoresce brightly when submitted to molecular bombardment from the negative pole of an induction coil. The ruby, emerald, diamond, alumina, yttria, samaria, and a large class of earthy oxides and sulphides emit light under these circumstances. Examined in a spectroscope, the light from some of these bodies gives an almost continuous spectrum, while that from others, such as alumina, yttria and samaria, gives spectra of more or less sharp bands and lines. The exhibitor showed photographs of a group of lines high up in the ultra-violet region, characteristic of a new element associated with yttrium, and separated by long fractionation. To this element the name Victorium has been given. The atomic weight of Victorium is probably near 117. In the purest state in which it has yet been prepared, Victoria is of a pale brown colour.

The Marine Biological Association showed (1) methods of feeding of marine animals, illustrated by living and preserved examples ; (2) charts illustrating the distribution of the fauna and bottom-deposits near the thirty-fathom line from the Eddystone Grounds to Start Point.

Mr. Adam Hilger showed the Michelson echelon grating spectroscope.

Prof. Arthur Thomson exhibited a model to illustrate how natural curliness of the hair is produced. Three factors require consideration in the production of curly hair : (1) the hair shaft, (2) the hair muscle, and (3) the sebaceous gland. Straight hair is always circular on section, and is usually thicker than curly hair, which is ribbon-like and fine. In order that the muscle may act as an erector in the hair, it is requisite that the shaft of the hair embedded of the skin should be sufficiently strong to resist any tendency to bend ; unless this be so the lever-like action necessary to produce its erection is destroyed. When the hair is fine and ribbon-like, the shaft is not sufficiently stout to resist the strain of the muscle and naturally assumes a curve, the degree of curvature depending on the development of the muscle, the resistance of the hair, and the size of the sebaceous gland. The curve thus produced becomes permanent and affects the follicle in which the hair is developed, the softer cells at the root of the hair accommodate themselves to this curve, and becoming more horny as they advance towards the surface, retain the form of the follicle, the cells on the concave side of the hair being more compressed than those on the convex side. In this way, the hair retains the form of the follicle after it has escaped from it.

Dr. Sorby, F.R.S., showed (1) Actiniæ and other marine animals killed by menthol and preserved in formalin in a fully expanded condition, and the same mounted as transparent lantern slides. The addition of a little menthol to sea water in which the animals are living causes them to expand very fully, and in many cases to die so. When completely dead they can be transferred to 4 per cent. formalin, and kept thus distended or mounted in balsam as lantern slides. (2) Various marine animals preserved as museum specimens in strong glycerine.

Prof. E. A. Schäfer, F.R.S., exhibited (1) specimens showing that after hemisection of the spinal cord Clarke's column undergoes atrophy on the same side below the lesion ; (2) specimens showing that the fibres of the pyramidal tract terminate at the base of the posterior horn and in Clarke's column, and not in the anterior horn ; (3) specimens showing that the fibres of the descending antero-lateral tract terminate in the anterior horn.

Prof. H. L. Callendar, F.R.S., exhibited recording pyrometers—platinum and thermo-electric.

Mr. W. Duddell showed an oscillograph for tracing alternate-current wave-forms. This oscillograph is arranged for tracing the wave-forms of potential difference and current in investigations with alternating currents. It is essentially a galvanometer which has the extremely short periodic time of one ten-thousandth (0·0001) second, and which is perfectly dead-beat, and has a sensibility, as arranged, of 300 mm. per ampere.

Prof. Hele Shaw and Mr. A. Hay showed how lines of force in a magnetic field could be determined by the stream lines of a thin film of viscous fluid, and also plotted from mathematical investigation.

Prof. W. F. Barrett showed a new thermo-electric combination, giving a nearly constant electromotive force through a wide range of changing temperature.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A meeting of the Junior Scientific Club was held on May 6. Mr. E. H. J. Schuster (New College) exhibited some excellent lantern slides of shore life.—This being the 200th meeting, Mr. G. C. Bourne (New College) read a very interesting paper on the early constitution of the Club, after which the Club adjourned. The officers for the ensuing term are—President, E. Gurney (New College). Secretaries, A. G. Gibson (Christ Church), H. E. Stapleton (St. John's). Treasurer, F. W. A. Fleischmann (Magdalen). Editor, F. W. Charlton (Merton).—Owing to medical advice, Prof. E. Ray Lankester, F.R.S., finds that he will be unable to deliver the Boyle Lecture of this year. Prof. J. G. McKendrick, F.R.S., has consented to take his place, and will lecture on "Musical sensations and the inner ear" on June 13.

CAMBRIDGE.—Prof. Sims Woodhead will deliver an inaugural lecture on the relations of pathology to modern medicine, in the Anatomy Theatre on May 23, at 2.30 p.m.

Mr. P. T. Main (sixth wrangler, 1862), who was for many years Lecturer in Chemistry and Superintendent of the Laboratory of St. John's College, died in his rooms on May 5.

The examinations in Agricultural Science for the University's diploma will extend from June 12 to June 19.

On November 7 two groups of colleges will hold examinations for entrance scholarships and exhibitions in Natural Science. One group includes Pembroke, Caius, King's, Jesus, Christ's, St. John's, and Emmanuel; the other Trinity, Clare, and Trinity Hall. The scholarships are of the value of 80*l.* a year and under. At the first group the subjects of examination are: (1) chemistry, (2) physics (including dynamics and hydrostatics), (3) physical geography (as introductory to geology), (4) animal physiology, (5) biology (including zoology and botany). In all branches of Natural Science there will be an examination in practical work. No candidate will be examined in more than *three* of the subjects numbered (1) to (5). Candidates who wish to offer elementary biology as a subject will be examined by means of the more elementary questions contained in the papers on biology. Opportunity will be afforded to candidates in biology to give evidence of their knowledge of natural history, and opportunity will also be given to candidates in physics to show proficiency in mathematics by means of a paper of a somewhat more advanced character than the *test paper* in mathematics. Those who wish to be examined in physical geography or physiology must give notice to that effect not later than October 23.

Information as to the range of the examination in physical geography may be obtained on application to any of the colleges.

At the second, the subjects are physics and chemistry. Papers will also be set in zoology, botany, physiology, geology, or other tripos subjects, provided that notice be given to the tutor not later than October 10. The notice should be accompanied by a list of the text-books which have been read by the candidate. Candidates for an emolument at Clare College may also offer elementary biology.

Further information may be obtained from any of the college tutors.

THE International Congress on Commercial Education was opened at Venice on Thursday last in the Senate Hall of the Doges' Palace. Signor Pascolato, the president, delivered the opening address, in which he bade the foreign representatives cordially welcome. Dr. L. Saignat, representing France, gave a review of the work accomplished in the five previous congresses on commercial education, and thanked the Government and the King and Queen of Italy for the reception accorded to them. Other speeches followed. At the afternoon sitting, the Congress discussed the subject of a commercial school, its purpose, its limits, and its organisation. Other cognate subjects were considered at subsequent meetings. The next Congress will be held in Paris in August 1900.

THE Committee of Council on Education in Scotland has resolved that a sum not exceeding 2000*l.* shall be added to the amount payable under the "Education and Local Taxation Account (Scotland) Act, 1892," towards defraying the cost of the inspection of higher class schools in Scotland, and of the holding of examinations for and granting the leaving certificates of the Scotch Education Department. They have also resolved that a sum not exceeding 2000*l.* shall be set aside for the further encouragement of agricultural education in Scotland, to be distributed on conditions which shall hereafter be set forth by the Scotch Education Department. The remainder of the balance available under the section is to be applied in aid of such higher class secondary or technical schools in Scotland as are not in receipt of grants under the Scotch Code.

IN the House of Commons on Monday, Mr. Gerald Balfour introduced a Bill to establish a Department of Agriculture and other Industries and Technical Instruction in Ireland. Describing the principal provisions of the Bill, the right hon. gentleman stated that, as far as concerned the transfer to the new department of existing Governmental functions, the measure closely resembles its predecessor, but that to the powers and duties formerly proposed to be transferred are now added those of the fishery inspectors and most of the functions exercised by the Science and Art Department. With regard to the machinery and funds for carrying out the work of developing agriculture and other industries, considerable changes have been introduced, and the provisions with respect to technical instruction are new. For the purposes of the Bill there will be placed at the disposal of the department, in addition to certain moneys annually voted by Parliament, a total income of between 160,000*l.* and 170,000*l.* a year. It is proposed that the chief sources of this income shall be the Imperial Exchequer, the Irish Church Fund, and the savings effected under the Judicature Act of 1897. 55,000*l.* is to be allocated to technical instruction of an urban character, and 10,000*l.* will go to purposes connected with sea fisheries. The rest of the money is to be used in connection with rural industries. The department is to be assisted by an agricultural board and a board of technical instruction, and only a minority of the members of these boards will be nominated by the Government. It is to be a general rule that no money is to be spent by the department in any local object without some contribution from local sources. The Bill was read a first time.

IN an address to students of the London Society for the Extension of University Teaching, delivered on Saturday afternoon in the Mansion House, Dr. Hill, Master of Downing College and Vice-Chancellor of the University of Cambridge, made the following remarks with reference to science teaching:—The too early teaching of science is not productive of permanent excellence in that department. The classical boys do far better, for they approach the new subject with an intelligence well drilled, with mental sinews well exercised and developed. The true way of approaching science at school is not to prepare boys for science scholarships, but to let scientific interests run like a thin line through school life—to induce a love of nature and beautiful objects. Experience in examining for the science tripos and the medical examinations is discouraging, and, astonishing as is the knowledge of facts displayed by candidates, their mental grip and conception of principle are unsatisfactory. But it is still to be remembered that a wrangler cannot be turned into a biologist, and mathematics dealing with abstractions are not well calculated to make a man a good observer of nature. The qualities needed for a man of science are many—quickness of observation, tenacity of memory, ratiocinative power—and no one course of study can be trusted to produce those results. The individual, however, is the main element, and there is needed in the several cases presented as great variety of mental as of physical nutriment for the body. In any case, however, wide sympathies are needed; the literary man would be the better for some knowledge of science, and the scientific man for a keen interest in literature. The University is charged sometimes with undue extension into technical subjects—to make men farmers, brewers, lawyers, and the like. It is not so, but the University desires to imbue the farmers and others who came to her with a love of knowledge, an elevated taste, a highly trained intelligence.

A GENERAL meeting of Convocation of the University of London was held on Tuesday, Mr. E. H. Busk, chairman of convocation, presiding. The *Times* reports that the Chairman, in replying to Prof. Silvanus Thompson, stated he could not say that, in the ordinary use of the word, negotiations were in progress for the transference of the business of the University to the Imperial Institute. If there were negotiations in progress they were only in a preliminary stage. The position of the matter was this. A communication was received from the Government requesting that a conference might take place between three representatives of the Treasury, three representatives of the University, and three representatives of the Imperial Institute—nine persons in all, who were to inspect the buildings and the grounds belonging to the Imperial Institute at South Kensington, and to consider whether those premises either were suitable or could be made suitable for the headquarters of the University in any way; and, if so, it was thought that the Government might enter into an arrangement with the authorities of the Imperial Institute which would enable them to make a proposal to the University. The nine representatives were duly appointed; they had inspected the building, but they had not yet reported. —Dr. H. F. Morley moved the reception of the report of the standing committee dealing with the regulations at the matriculation examination, aud recommending various resolutions for adoption by Convocation. The report was received. Dr. Morley then moved a resolution requesting the Senate to adopt for the matriculation examination a scheme of subjects which was in complete accordance with the scheme that was unanimously adopted by the meeting of delegates from the Board of Studies in the Faculty of Arts. After some discussion the scheme of subjects was adopted by the house in the following form:—(1) Latin (two papers); (2) English (two papers); (3) mathematics (two papers); (4) any two of the following five languages:—Greek, French, German, Sanskrit, Arabic; and (5) one of the following five sciences:—Elementary mechanics, elementary chemistry, elementary sound, heat, and light, elementary magnetism and electricity, and elementary botany.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, April.—Prof. F. N. Cole gives an abstract of the *Proceedings* of the February meeting of the Society. For nearly a year plans have been under discussion for providing facilities for the publication of the increasing number of original mathematical papers produced in America. The Committee appointed at the last summer meeting have reported that it is desirable and feasible that the Society should undertake the periodical publication of *Transactions*, and that a commencement should be made in January 1900.—Nineteen papers were presented at the meeting.—Abstracts are given of papers by Prof. Macfarlane (on the imaginary of geometry), by Prof. Osgood (on a means of generating a function of a real variable whose derivative exists for every value of the argument, but is not integrable), by Prof. Lovett (on a certain class of invariants), by Dr. Snyder (lines of curvature on annular surfaces having two spherical directrices), by Dr. Miller (on the primitive groups of degree 17), by Dr. Dickson (concerning the abelian and hypo-abelian groups), by Mr. Hedrick (on three-dimensional determinants), and by Dr. Ling (an examination of groups whose orders lie between 1093 and 2000).—Prof. Webster exhibited a large number of curves traced by the motion of a rotating top.—Prof. J. M. Peirce follows the above notice with an abstract of his paper on determinants of quaternions, read at the above meeting.—The largest linear homogeneous group with an invariant pfaffian, by Dr. L. E. Dickson, was read at the October meeting of the Society.—Asymptotic lines on ruled surfaces having two rectilinear directrices, by Dr. Snyder, was communicated (partially) at the August and December meetings. There are several diagrams. The theorem discussed is every ruled surface contained in a linear complex has an asymptotic line, all of whose tangents belong to the complex (*cf.* Clebsch, "Ueber die Curven der Hauptstangenten bei windschiefen Flächen," *Crelle*, vol. lxviii.; and Bonnet, "Théorie générale des Surfaces," *Journ. de l'École Polytechnique*, vol. xxxii.).—There are reviews of "Theoretical and Practical Graphics," by F. N. Willson, of "The repertorio di matematiche superiori, i. Analisi per E. Pascal," and of "D'Ocagne's Cours de Géométrie descriptive et de Géométrie infinitésimale." The last two notices are by Prof. Lovett, who also contributes a translation of Prof. G. Darboux's obituary sketch of Sophus Lie (*Comptes rendus*, February 27).—Interesting notes and publications close the number.

Bollettino della Società Sismologica Italiana, vol. iv., 1898, No. 8.—Obituary notice of P. Landi.—On the different methods of determining the position of the epicentre in distant earthquakes of unknown origin, by G. Agamennone and F. Bonetti. The authors argue that methods which depend on the length of the interval between the two series of undulations and on their direction cannot give trustworthy results. They prefer one based on the time-records of a particular phase of the movement, and they would make use of the slow-period pulsations rather than the earlier tremors, since the latter may traverse the body of the earth with a velocity depending on the density, while the former travel along the surface with a nearly constant velocity.—Two-component seismoscope, by C. Guzzanti.—Notices of the earthquakes recorded in Italy (November 27–December 31, 1897), by G. Agamennone, the most important being the Umbria and Marches earthquake of December 18–22.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 20.—"Studies in the Morphology of Spore-producing Members. IV. Leptosporangiate Ferns." By F. O. Bower, Sc.D., F.R.S., Regius Professor of Botany in the University of Glasgow.

An attempt has been made in this memoir to strengthen the characters derived from the sorus by a fresh examination of its details, and certain of its features are used for purposes of general comparison which have hitherto received little attention; they are:—

(1) The relative time of appearance of sporangia of the same sorus.

(2) Certain details of structure of the sporangium, including its stalk.

(3) The orientation of the sporangia relatively to the whole sorus.

(4) The potential productiveness of the sporangium as estimated by its spore-mother cells, and the actual spore-output.

Observations of these features extending over all the more important living genera, coupled with data of habit and the characters of the Gametophyte as collateral evidence, have led the author to divide the homosporous ferns thus:—

Simplices	Marattiaceæ	Eusporangiate
	Osmundaceæ	Leptosporangiate
	Schizæaceæ	
	Gleicheniaceæ	
	Matonineæ	
Gradatæ	Loxsomaceæ	
	Hymenophyllaceæ	
	Cyatheaceæ	
	Dicksonieæ	
	Dennstaedtiinæ	
Mixtæ ...	The bulk of the Polypodiaceæ	

The effect of the observations and comparisons in this memoir is rather confirmatory of the current classifications than disturbing. The divisions suggested would supersede those of Eusporangiatæ and Leptosporangiatæ, though these terms would still be retained in a descriptive sense. If the sub-orders Osmundaceæ, Schizæaceæ, and Marattiaceæ be transferred from the end of the Synopsis Filicum to the beginning, and grouped with *Gleichenia* and *Matonia*, we have the "Simplices" before us. They are characterised by the simultaneous origin of the sporangia. The Gradatæ, in which the sporangia are produced in basipetal succession, include the Cyatheaceæ, Dicksonieæ (*Excl. Dennstaedtia*), Hymenophyllaceæ, and Loxsomaceæ, sequences probably of distinct descent, and probably derivative from some prior forms such as the Simplices; and in the arrangement of Sir Wm. Hooker they hold a position following on the Gleicheniaceæ. The family of Dennstaedtiinæ, founded by Prantl to include *Dennstaedtia* and *Microlepia*, also has its place here, but it leads on by intermediate steps to undoubtedly mixed forms in which various ages of sporangia appear without regular sequence, such as *Davallia*, *Cystopteris*, *Lindsaya*, and the Pterideæ. But this sequence is already laid out in this order in the Synopsis, and it illustrates one at least of the lines along which mixed forms are believed to have been derived from the Gradatæ. No attempt has been made to follow the natural grouping of the Mixtæ into detail, or to test the arrangement of them in the Synopsis. Sufficient has, however, been said to show that the systematic divisions of the ferns now proposed fall in readily with the system of Sir William Hooker, notwithstanding that they are based upon details of which he cannot have been aware.

"The Physiological Action of Choline and Neurine." By F. W. Mott, M.D., F.R.S., and W. D. Halliburton, M.D., F.R.S.

The cerebro-spinal fluid removed from cases of brain atrophy after death or during life, particularly from cases of general paralysis of the insane, produces when injected into the circulation of anæsthetised animals a fall of arterial pressure, with little or no effect on respiration. This pathological fluid is richer in proteid matter than the normal fluid, and among the proteids, nucleo-proteid is present. The fall of blood pressure is due to an organic substance, which by chemical methods was identified as choline.

The nucleo-proteid and choline originate from the disintegration of the brain tissue, and their presence indicates that some of the symptoms of general paralysis may be due to auto-intoxication; these substances pass into the blood, for the cerebro-spinal fluid functions as the lymph of the central nervous system. We have identified choline in the blood removed by venesection from these patients during the convulsive seizures which form a prominent symptom in the disease.

Normal cerebro-spinal fluid does not contain nucleo-proteid or choline, and produces no effect on arterial pressure.

Our proof that the material we have worked with is choline rests not only on chemical tests, but also on the evidence afforded by physiological experiments; the action of the cerebro-spinal substance exactly resembles that of choline. Neurine, an alkaloid closely related to choline, is not present in the fluid;

its toxic action is much more powerful, and its effects differ from those of choline.

The fall of blood pressure is in some measure due to its action on the heart, but is also produced by dilatation of the peripheral vessels, especially in the intestinal area. The drug causes a marked contraction of the spleen, followed by an exaggeration of the normal curves, due to the alternate systole and diastole of that organ.

The action on the splanchnic vessels is due to the direct action of the base on the neuro-muscular mechanism of the blood vessels themselves.

The fall of blood pressure is abolished by atropine. This observation has some bearing on general paralysis, for the arterial tension in that disease is usually high, not low, as it would be if choline were the only toxic agent at work.

Neurine produces a fall of arterial pressure, followed by a marked rise, and a subsequent fall to the normal level. Sometimes, especially with small doses, the preliminary fall may be absent. Sometimes, especially with large doses, by which presumably the heart is more profoundly affected, the rise is absent.

The slowing and weakening of the heart account for the preliminary fall of blood pressure.

The rise of blood pressure which occurs afterwards is due to the constriction of the peripheral vessels, evidence of which we have obtained by the use of oncometers for intestine, spleen, and kidney.

After the influence of the central nervous system has been removed by section of the spinal cord, or of the splanchnic nerves, neurine still produces its typical effects.

After, however, the action of peripheral ganglia has been cut off by the use of nicotine, neurine produces only a fall of blood pressure. It therefore appears that the constriction of the vessels is due to the action of the drug on the ganglia.

It produces a marked effect on the respiration. This is first greatly increased, but with each successive dose the effect is less, and ultimately the respiration becomes weaker, and ceases altogether. The animal can still be kept alive by artificial respiration.

The exacerbation of respiratory movements will not account for the rise of arterial pressure; the two events are usually not synchronous, and an intense rise of arterial pressure may occur when there is little or no increase of respiratory activity or during artificial respiration.

After atropine, injection of neurine causes only a rise of blood pressure, which is accompanied with constriction of peripheral vessels.

Chemical Society, April 20.—Prof. Thorpe, President, in the chair.—The following papers were read:—The synthesis of some $\beta\beta'$-dipyridyl derivatives from citrazinic acid, by W. J. Sell and H. Jackson. Citrazinic acid yields a nitroso-derivative

$$\mathrm{COOH.C}\!\!<\!\!\begin{array}{l}\mathrm{CH_2 \text{———} CO}\\ \mathrm{C(NO).C(OH)}\end{array}\!\!>\!\!\mathrm{N},$$

from which a number of dipyridyl derivatives have been obtained.—Action of hydrogen peroxide on carbohydrates in the presence of iron, by R. S. Morrell and J. M. Crofts. Both glucose and lævulose are oxidised by hydrogen peroxide in presence of iron salts with formation of glucoson; under similar conditions, arabinose yields arabinoson.—The condensation of oxalic acid and resorcinol, by J. T. Hewitt and A. E. Pitt. The condensation product of oxalic acid with resorcinol in presence of sulphuric acid contains a compound of the composition $C_{20}H_{14}O_7$, which is probably a carboxylic acid.—Ethyl ammonium sulphite, by E. Divers and M. Ogawa. Ethyl ammonium sulphite is formed by the interaction of ammonia and sulphur dioxide dissolved in alcohol; it is immediately converted into alcohol and ammonium pyrosulphite by water.—Ethyl ammonium selenite and non-existence of amidoselenites (selenosamates), by E. Divers and S. Hada.—The allotropic modifications of phosphorus, by D. L. Chapman. Metallic and red phosphorus are identical, and the vapours of red and yellow phosphorus are also identical; red phosphorus melts, forming ordinary phosphorus, under pressure at the melting point of potassium iodide.—On the interaction of mercurous and mercuric nitrites with the nitrites of silver and sodium, by P. C. Rây.—β-Isopropylglutaric acid, by F. H. Howles and J. F. Thorpe. A new method of preparing β-isopropylglutaric acid from ethylic α-bromisobutylacetate is given.—The synthesis and preparation of terebic and terpenylic acids, by W. T. Lawrence. β-Isopropylglutaric acid is oxidised by chromic acid mixture with formation of terpenylic acid; the constitution of the latter is therefore

$$\begin{array}{l}\qquad\qquad\;\mathrm{CMe_2.O}\text{——}\!\!\!\!\!\!\!\!\!\quad\rceil\\ \qquad\qquad\quad\;|\qquad\quad\;|\\ \mathrm{COOH.CH_2.CH.CH_2.CO.}\end{array}$$

—Position-isomerism and optical activity; the comparative rotatory powers of methylic and ethylic ditoluylglycerates, by P. Frankland and H. Aston.—Fencholenic acid, by G. B. Cockburn. Fenchonoxime, when heated with dilute sulphuric acid, yields a mixture of two nitrites, which in turn give isomeric acids on hydrolysis.—The action of certain acidic oxides upon salts of hydroxy-acids, Part iv., by G. G. Henderson, T. W. Orr, and R. J. G. Whitehead.

Royal Microscopical Society, April 19.—Mr. E. M. Nelson, President, in the chair.—The President called special attention to two old microscopes; the first, which had been presented to the Society by Mr. J. M. Offord, was signed "Adams," and was a very interesting model which filled up a gap in the historic collection of the Society. Its probable date was about 1785–95. The second microscope, which had been presented by Dr. Dallinger, was one full of interest, and evidently constructed about the end of the last century; it was the earliest example in the Society's collection of a microscope with rack-work limb.—Dr. Hebb exhibited, on behalf of Miss Latham, two slides of blood which had been stained with methylen blue; one was of normal blood which had retained the blue stain, the other was of blood from a diabetic person; but in this the blue had been discharged, probably by the action of the glucose which is present in the blood in this disease.—Owing to illness Prof. Lionel Beale was unable to be present to read his paper.—Dr. Hebb read a letter from Mr. Bryce Scott, who said if any Fellows cared for West India dredgings rich in Foraminifera, he would be pleased to forward them some.—The President then, on behalf of the Society, presented to Mr. T. H. Powell an enlarged framed copy of the portrait of his father, the late Mr. Hugh Powell, which is issued as a frontispiece in the current number of the *Journal*.—The President then made a few remarks upon the theory and construction of eye-pieces for the microscope.—At the next meeting it is hoped Dr. H. C. Sorby will read a paper on the preparation of microscopical specimens of marine worms, and that there will be an exhibition of pond-life.

PARIS.

Academy of Sciences, May 1.—M. van Tieghem in the chair.—On continued groups, by M. H. Poincaré.—Iodine in sea water, by M. Armand Gautier. Iodine does not appear to exist in sea water in the form of iodides, since five litres gave a negative result. It would appear to be present in minute organisms, and amounts up to 2·4 mgr. per litre were found from this source. One-fourth of the total amount of iodine present can be separated by filtering through porcelain.—On traumatism and tuberculosis, by MM. Lannelongue and Achard.—Separation into two natural groups of the volcanic outflow of Mt. Dore; the distinctive chemical characters of their magmas, and of that supplying the eruptions of the "puys" of Auvergne, by M. Michel Lévy.—On a generalisation of Fermat's theorem, by M. L. E. Dickson.—On a transcendental equation and linear differential equations of the second order with periodic coefficients, by M. A. Liapounoff.—Note on the development of an arbitrary function and on a series proceeding according to harmonic functions, by M S. Zaremba.—Radioconductors with metallic spheres, by M. Édouard Branly. Columns of from six to fifteen balls of various metals were placed in series with a battery and electric bell. On exposing this column to the electric waves arising from a small induction coil, brusque variations of resistance are set up, causing the bell to ring. Thus with steel the resistance under these conditions fell from 2060 ohms to 120 ohms, with aluminium from 20,660 to 280 ohms, the resistance being in both cases restored by giving a slight shock to the column.—The production of chains of electrolytic deposits, and the probable formation of invisible conducting chains in distilled water under the action of induced currents and electric waves, and on a curious oscillation phenomenon produced in distilled water by induced currents of low frequency, by M. Thomas Tommasina.—On the magnetic rotatory polarisation of quartz, by M. Arnold-Borel.—Chemical analysis of some volcanic rocks arising from the peripheral cracking of Mt. Dore, by M. E. Bonjean. Eleven analyses are given of phonolites, trachytes, tephrites, and basalts.—On a crystallised double carbonate of cerium peroxide, by M. André Job. The salt has the composition $Ce_2O_3.(CO_3)_3.4K_2CO_3.12H_2O$, and arises from the action of hydrogen peroxide upon cerium salts, and also by spontaneous oxidation.—On a fluorine compound supposed to be contained in certain mineral waters, by M. F. Parmentier. The effects produced upon glass, hitherto supposed to have been produced by fluorides in certain mineral waters, are shown to be due to a deposit of silica. No trace of fluorine has been detected in numerous analyses of mineral waters.—On the oxidising power of the alkaline periodates, by M. E. Péchard. The salt $NaIO_4$ behaves as an oxidising agent towards ferrous salts and potassium iodide.—Displacement of mercury by hydrogen, by M. Albert Colson. Mercuric oxide is slowly reduced by hydrogen at 100°, the amount of mercury formed being proportional to the weight of oxide actually present. The yellow and red oxides are reduced at different rates, the red being the slower of the two. Mercurous oxide is not attacked by hydrogen at 100°.—Luminous phenomena produced by the action of certain ammoniacal salts upon fused potassium nitrite, by M. D. Tommasi.—Morphine and its salts, by M. Émile Leroy. A study of the heats of combustion and formation of various salts of morphine.—On the production of the racemoid forms of camphor, by M. A. Debierne.—On the unsymmetrical tetramethyl derivative of diamido-diphenylethane, by M. A. Trillat.—On the sugar from maize stems, by MM. C. Istrati and G. Oettinger.—On the absorption of iodine by the skin and its localisation in certain organs, by M. F. Gollard.—Detection and colorimetric estimation of minute quantities of iodine in organic substances, by M. Paul Bourcet.—The electrical treatment of gout, by M. Th. Guilloz.—On the structure of the anal glands in *Dysticus* and the supposed defensive *rôle* of these glands, by M. Fr. Dierckx.—Sporozoa in the digestive tube of the blind-worm, by M. Louis Léger.—On the quantitative variations of the plankton in the Lake of Geneva, by M. Émile Yung.—Fall of a meteorite recently observed in Finland, by M. Stanislas Meunier.—On a new mercury pump, by M. E. U. Chatelain.

DIARY OF SOCIETIES.

THURSDAY, MAY 11.

MATHEMATICAL SOCIETY, at 8.—The Zeroes of a Spherical Harmonic $P_n^{m}(\mu)$ considered as a Function of n: H. M. Macdonald.—On the Statistical Rejection of Extreme Variations, Single or Correlated (Normal Variation and Normal Correlation): W. F. Sheppard.

FRIDAY, MAY 12.

ROYAL INSTITUTION, at 9.—Magnetic Perturbations of the Spectral Lines: Prof. Thomas Preston, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Observations of Swift's Comet 1899, made at Grahamstown, South Africa: L. A. Eddie.—Observations of Mars made at Mr. Crossley's Observatory, Bermerside, Halifax, during the Opposition 1898–99: Joseph Gledhill.—Note on the Spectra of γ Cassiopeiæ and o Ceti: Rev. W. Sidgreaves.—Longitude from Moon Culminations: D. A. Pio.——*Probable Papers*: Note on an Elbow Form of Reflecting Telescope: Dr. A. A. Common, F.R.S.—Observations of the Satellite of Neptune from Photographs taken with the 26-inch Refractor of the Thompson Equatorial: Royal Observatory, Greenwich.

PHYSICAL SOCIETY, at 5.—Note on the Vapour Pressure of Solutions of Volatile Substances: Dr. R. A. Lehfeldt.—Note on the Discussion of their Paper on the Criterion for an Oscillatory Discharge of a Condenser: Prof. W. B. Morton and Dr. Barton.—Exhibition of a Quadrant Electrometer: G. L. Addenbrooke.

MALACOLOGICAL SOCIETY, at 8.—On *Planispira* (*Cristigibba*) *Buruensis* and *Omphalotropis hercules*, New Species from Buru: J. H. Ponsonby and E. R. Sykes.—Note on the Nervous System of *Ampullaria urceus*: R. H. Burne.—Notes on some Marine Shells from North-West Australia, with Description of New Species: E. A. Smith.—Descriptions of *Sigaretus Drewi*, n.sp. (Fossil) and *Cirsonella neozelanica*, n.sp. from New Zealand: R. Murdoch.—Notes on some New Zealand Land Mollusca: R. Murdoch.

SATURDAY, MAY 13.

GEOLOGISTS' ASSOCIATION (Liverpool Street, G.E.R.), at 2.—Excursion to Ilford.

MONDAY, MAY 15.

VICTORIA INSTITUTE, at 4.30.—The Physical and Mental Attributes of the Sexes: Dr. A. T. Schofield.

TUESDAY, MAY 16.

ROYAL INSTITUTION, at 3.—Recent Advances in Geology: Prof. W. J. Sollas, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.

ROYAL STATISTICAL SOCIETY, at 5.—Life Tables: their Construction and Practical Uses: T. E. Hayward.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Specimens of Work with Irregular Grained Screens, &c.

WEDNESDAY, MAY 17.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Mean Temperature of the Surface Waters of the Sea round the British Isles, and its Relation to that of the Air: H. N. Dickson.—Some Phenomena connected with the Vertical Circulation of the Atmosphere: Major-General H. Schaw, C.B.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Pond Life.

THURSDAY, MAY 18.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Crystalline Structure of Metals: Prof. Ewing, F.R.S., and W. Rosenhain.——*Probable Papers*: The Yellow Coloring Matters accompanying Chlorophyll and their Spectroscopic Relations: C. A. Schunck, F.R.S.—The Diffusion of Ions into Gases: J. S. Townsend.—The Diurnal Range of Rain at the Seven Observatories in connection with the Meteorological Office, 1871–1890: Dr. R. H. Scott, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design: P. V. McMahon.

CHEMICAL SOCIETY, at 8.—Corydaline, Part VI.: Dr. J. J. Dobbie and A. Lauder.—Oxidation of Furfural by Hydrogen Peroxide: C. F. Cross, E. J. Bevan, and T. Freiberg.

FRIDAY, MAY 19.

ROYAL INSTITUTION, at 9.—Runic and Ogam Characters and Inscriptions in the British Isles: The Lord Bishop of Bristol.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Zur Anthropologie der Badener: O. Ammon (Jena, Fischer).—A Class-Book of (Elementary) Practical Physiology: Dr. de B. Birch (Churchill).—Geometrical Drawing: E. C. Plant, Vol. 1, Practical Plane Geometry (Macmillan).—Medical Missions in their Relation to Oxford: Sir H. W. Acland, 2nd edition (Frowde).—The Hygiene of the Mouth: R. D. Pedley (Segg).—Die Physikalischen Erscheinungen und Kräfte ihre Erkenntnis und Verwertung im Praktischen Leben: Prof. L. Grunmach (Leipzig, Spamer).—Outlines of Physical Chemistry: Prof. A. Reychler, translated by Dr. J. McCrae (Whittaker).—L'Éclairage a Incandescence par le Gaz et les Liquides Gazéifiés: P. Truchot (Paris, Carré).—Transactions of the American Pediatric Society, Vol. x. (New York).—Elements of Quaternions: Sir W. R. Hamilton, 2nd edition, Vol. 1 (Longmans).—Mechanics applied to Engineering: Prof. J. Goodman (Longmans).—Text-Book of Practical Solid Geometry: Captain E. H. de V. Atkinson (Spon).—Steinbruchindustrie und Steinbruchgeologie: Dr. O. Hermann (Berlin, Borntraeger).—The Naval Pioneers of Australia: L. Becke and W. Jeffery (Murray).—Applied Geology: J. V. Elsden, Part 2 ("Quarry" Publishing Company).—A Guide to Recent Large Scale Maps (London).

PAMPHLETS.—Mines and Quarries, General Report, &c., for 1898, Part 1 (London).—The Geology of the Country around Carlisle: T. V. Holmes (London).

SERIALS.—Travaux de la Société Impériale des Naturalistes de St. Pétersbourg, Vol. xxvii. livr. 5 (St. Pétersbourg).—Sunday Magazine, May (Isbister).—Good Words, May (Isbister).—Chambers's Journal, May (Chambers).—National Review, May (Arnold).—Contemporary Review, May (Isbister).—Pearson's Magazine, May (Pearson).—Century Magazine, May (Macmillan).—Proceedings of the American Philosophical Society, December (Philadelphia).—Humanitarian, May (Duckworth).

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