THURSDAY, APRIL 19, 1883

THE SCOTCH UNIVERSITIES BILL

THE long expected Scotch Universities Bill has at last made its appearance. As no explanation of its provisions has yet been offered in Parliament, and the Scotch newspapers have shown the caution characteristic of their country in declining to commit themselves to an opinion about it till they learn what its authors have to say in its favour, it may be interesting to our readers to know what the Bill proposes to do and how it proposes to do it. So much at least can be stated in a few sentences. The Scotch Universities derive a considerable portion of their revenues from Parliamentary grants. The Bill proposes to give them a sum which is estimated at about 8000*l*. a year, or 25 per cent., more than they now get; to remove the whole of their payment from public moneys from the annual estimates to the Consolidated Fund; to settle this sum of 40,000*l*. on them "in full discharge of all claims past, present, and future," and to cut them adrift. They now get really about 28,000*l*. annually, the other 4000*l*. going to two institutions—the Royal Observatory in Edinburgh, and the Botanic Garden there, which are in future to be handed over to the University of Edinburgh and to be maintained by it out of the portion of the 40,000*l*. to be allocated to it. The allocation of this sum as between the Universities is to be made once and for ever by a new Executive Commission, with whose judgment, except in the form of a somewhat complicated and expensive appeal to Her Majesty in Council and the usual formal laying of their ordinances on the table of Parliament, the State will not farther concern itself.

The second main provision of the Bill is that these Commissioners are directed to make ordinances, subject only to the same appeal, regulating everything in or concerning these Universities, and in particular fixing anew the *constitution* and functions of all the various University bodies and officers, such as the University Court, the University Council, the Senatus Academicus, the chancellor, the rector, the assessors, and all other University officers. They are directed in only two particulars. They are to institute a first examination which is to be compulsory on all persons who intend to graduate in Arts or in any other Faculty, and to institute if they think fit, in any or all of the Universities, a new Faculty of Science, subject to these particular directions: they are to "regulate the manner and conditions in and under which students shall be admitted, the course of study and manner of teaching, the amount and exaction of fees, the length of the academical session or sessions, and the manner of examination."

The next important duty imposed on the Commissioners is to report within twelve months whether in their opinion it is no longer possible for the University of St. Andrews, which is the oldest and by far the least numerously attended of the four, "in consequence of the want of sufficient endowments," to "continue to perform its functions with advantage," and in the event of their so reporting they are to make "suggestions for dissolving that University and its Colleges, and creating a new corporation to which the funds and property of the University and Colleges shall be transferred."

There is another curious provision, which we mention only from the interest which will generally attach to it, not because we should venture in this place to express any opinion about it, in one way or another. Like all the Universities in the kingdom, except London and the new Victoria University, the Scotch Universities have a Faculty of Theology. This has been hitherto in direct connection with the Scotch Established Church, and the Professorships can only be held by clergymen of that Church. It is well known that the Nonconformist denominations in Scotland prescribe a professional course of their own for students preparing for their ministry, and the two great Presbyterian nonconforming bodies have each of them Colleges and Professors, whose lectures their students must attend. The Bill provides that from this time forward no test of any kind shall be applicable to the University Chairs of Theology, which may therefore either be held by clergymen of any persuasion or by laymen. Should this provision become law, it will be most interesting to watch what may be the tendencies and character of the new scientific theology which will develop itself in Scotland after it has been freed from the trammels of any creed. It is to be feared, indeed, that the first effect may be that the students who now attend the University Chairs of Theology may be directed elsewhere to new Colleges or Halls of Presbyterian theology taught from the point of view of the Established Church, and that the rising clergymen of the nation, who are generally of opinion that they do enough when they do all that their licensing bodies require of them, may not sit in great numbers at the feet of the occupants of the new scientific Chairs. There is another provision which illustrates in a singular way the jealousy with which a lay State can scarcely help regarding theology, even after it has become scientific, and "in the abstract." Whatever happens, whoever may benefit by the 25 per cent. of increased emolument to be made over to the Scotch Universities, it is expressly provided that the scientific theologians are never to get any of it.

The most interesting question to our readers is how the new Bill will influence the progress of science in the Scotch Universities. The obvious and only answer is that nobody can tell. The Commissioners may make provision for a Faculty of Science, and in the three younger and more numerously attended Universities they will probably do so. In Edinburgh they could certainly do so without requiring to create new Chairs. In Glasgow there is not at present a Chair of Geology, though that subject is taught in an old-fashioned alliance with zoology, by the single Professor of Natural History. There is no Professor of Geology or of Astronomy or of Engineering in Aberdeen. The foundation of new Chairs on these subjects may possibly be thought necessary before a Faculty of Science is instituted; and there are medical Chairs, like that for Pathological Anatomy, which are not established in Glasgow. A great deal will depend, in fact, on the extent to which the free balance of 7500*l*. or thereabouts may be found sufficient to meet the more urgent and immediate demands which will be made on it from all quarters. Glasgow and Aberdeen have no Chair of Modern History. In Aberdeen one Professor teaches English Literature and Logic, and there is no Chair of Political Economy. In the University of Adam Smith

Political Economy is only taught by the incumbent of the Chair of Moral Philosophy. The recommendations of the Inquiry Commissioners stated urgent wants of the Universities five years ago which would amount to much more than the added 25 per cent. now to be given to the Commissioners to settle upon the Universities for ever. It is true that Scotland is now both a rich and a liberal country, and that much may be expected in future from the direct contributions of her people. But experience has abundantly shown that private benevolence is never organised benevolence, and that sums which might in the aggregate be sufficient to meet all the most urgent wants of the Universities are not to be expected to be provided by voluntary contributions where or when they are most wanted. To reorganise the Scotch Universities, a liberal provision of public money is probably necessary, and it seems strange to throw the burden of such a provision on a fixed and moderate sum, which is declared to be for ever incapable of increase. It is not for us of course to consider whether Parliament would act wisely in placing the grants for the Scotch Universities on the annual estimates, where they are always open to comparison and challenge, or on the Consolidated Fund, where they are practically liable neither to increase nor to diminution. But it seems a strange policy to declare beforehand that the grants for objects which are admitted to be of national importance shall never exceed a severely limited sum. The demands of science alone are continually increasing in pecuniary severity, and we say no more than every one will admit when we add, that it is not for the public advantage that the natural teaching of science should be hindered in any of the three kingdoms by a too rigid or mechanical economy. It is not placing her in her true position to compel her to an undignified struggle with a host of other claimants for her fair share of a moderate allowance which cannot be increased. If the Scotch Universities had great College estates and ample revenues like Oxford and Cambridge, her claims might be met from time to time as they have been in England. Until of late years they have been very moderately provided institutions, and there are no available funds for the extensions of the future but the freewill offerings of her people. The State is, in our opinion, reasonably expected from time to time to organise, or to help to reorganise them in the interests of the nation. We should like to see it ready to do something more in that way than to offer to cut them adrift with a little extra money, and to provide Commissioners to whose absolute discretion is to be intrusted the reconstructive duties which naturally devolve on Parliament. The Oxford and Cambridge Act of 1877 gave the Commissioners then appointed very extensive powers, but it was in marked contrast, in the precision and fulness of its enacting clauses, and in the checks under which the Commissioners were to exercise their functions, to the Scotch Universities Bill of 1883.

THE SCHEME OF THE GROCERS' COMPANY FOR THE ENCOURAGEMENT OF ORIGINAL RESEARCH IN SANITARY SCIENCE

THE relation of man, whether savage or civilised, to his surroundings is one of constant exposure to influences which are hostile to his bodily well-being. Some of these are dangerous chiefly by reason of their insidiousness; others, although not concealed, are in their nature unavoidable; others, though both known and avoidable, are yet for various reasons not avoided. All of them, of whichever class, are subjects of earnest study to the pathologist, one part of whose science is for this reason called etiology as relating to the *causes of disease*, the other being concerned with the disturbances which these causes induce inside the living human organism. "Sanitary Science" in so far as it is a science, is identical with etiology, and is therefore a branch of pathology. In this sense it is the science on which the art of preventing disease, or "Preventive Medicine," as it is commonly called, is founded, and it will be admitted that, whatever doubt may exist as to the utility of exact knowledge of the nature of disease for its cure, there can be none as to its direct applicability to prevention.

The Grocers' Company, one of the oldest and most distinguished of the City Guilds and second to none in the liberality with which it has always bestowed its funds for the general good, has thought fit to create an endowment, or rather a system of endowments, for the encouragement of "Original Research in Sanitary Science." This it defines as relating to the "causes of important diseases and the means by which the respective causes may be prevented or obviated." The endowments which the Company have created are of two kinds. The one is intended "as maintenance for work in progress in fields of research to be chosen by the worker," the other as reward for actual discovery; the former intention being carried into effect by the establishment of three "Research Scholarships," each of 250*l.* a year, the latter by the appointment of a "Discovery Prize" of 1000*l.*, to be given once in every four years. With a special view to the promotion of pathological study in the United Kingdom and its dependencies, the Scholarships are limited to British subjects who must be under thirty-five years of age; but in all other respects they are entirely open to persons *cujuscunque ordinis sive professionis.* Candidates are expected to state precisely the researches they propose to undertake, and are invited to refer, in support of their applications, to any work they may have in progress or may have published in the same or in any kindred field of study. In the appointment to Scholarships preference will be given to those candidates whose researches are judged likely to result in increase of knowledge of the "*Causation or Preventability of some important Disease or Diseases.*" It is further provided that towards the close of his year of scholarship each scholar shall publish the result of his research or researches either in print, or, if desired, in a lecture to be delivered at Grocers' Hall or elsewhere.

The Quadrennial Discovery Prize is intended to reward original investigations, irrespectively of the country in which they may have been made, which shall have resulted in important additions to exact knowledge in particular (previously defined) subjects. The subject for the first Discovery Prize will be announced in May next, and the award will be made in May, 1887, when a further subject for investigation will be proposed. Any treatise which the candidate may have published, whether in England or in any other country, at any time during the period allowed, will be accepted as a competition-treatise, provided that the author has duly declared himself a candidate. Every treatise must be in print and in the English language, and must bear the name of its author. It seems to be contemplated that some definite problem will always be involved in the subject announced, the solution of which will be considered as the essential condition of success. But if it shall appear that although this has not been accomplished any candidate has made valuable progress towards its accomplishment, or has even incidentally made some discovery of practical importance, the merits of such candidate will be recognised by the award of a part of the sum offered.

Such is the scheme; we think it will be generally regarded as well adapted for the accomplishment of the end proposed. The objections to which it is liable are exclusively those which are applicable to all similar schemes for the encouragement of research by pecuniary endowment.

To the Discovery Prize we attach less value than to the other. In the natural sciences discoveries are usually made by men to whom the prospect of a reward, however munificent, would not be a sufficiently strong reason to induce them to change the course or purpose of their investigations. It is the consideration of this fact, no doubt, which has led the Company, we think very wisely, to determine to accept published researches in competition; but here the difficulty at once arises, for the discovery must relate to a particular question previously announced. How will the selection of this question be made?

It is clearly desirable that on each occasion the problem selected should be one which will certainly meet with its solution during the next four years—and therefore one as to which investigation is already in progress. To anticipate what will and must soon be discovered is half way towards discovery, and consequently demands, on the part of the individuals intrusted with the selection, powers at least equal to those which it is proposed to recognise in the bestowal of the prize. Nothing could be better than that Prof. Tyndall, Mr. Simon and the other scientific advisers of the Company should have the opportunity given them, or rather the duty imposed upon them, of publishing these forecasts of the probable progress of knowledge in relation to the causes of disease, for, even if their prognostications serve no other purpose, they will at least be of use in directing inquiry into the most promising channels.

The more important division of the scheme—that which relates to the scholarships—is open to no objections of the kind referred to above. Its purpose is simple, and the way in which it is proposed to carry it out effectual. It is of course quite as impossible to make a worker of a man by giving him a scholarship as to make a discoverer of him by offering him a prize, but there is this difference between the two cases, that the endowment *enables*, the prize only *rewards*. The scholarships are limited to candidates under thirty-five. Among men of this age who are now working at pathology in this country we may be sure that there are some who are doing so, if one may so express it, at the cost of life, for they are devoting to investigations which certainly will not pay, time which could otherwise be spent with direct advantage to themselves; and that there are among such men some at least who are fitted by nature to undertake the work of investigation, and have the additional qualifications afforded by training in scientific methods. Their number is no doubt very inconsiderable, for pathology as a science is of very recent birth. It is the offspring of physiology, and has only just arrived at such a stage of development as to claim an independent position. By reason of its being in this evolutionary condition it happens in pathology, as in all other sciences during the initial stage of their growth, that the more work is done the more is required—the completion of each bit of research only preparing the way for fresh investigations. New methods, new applications of physical, chemical, or physiological knowledge to the problems which relate to the causes of disease, are being brought within reach of the pathological worker every year, but all of these require *work* to make them fruitful. There is therefore not the least reason for apprehending that there will be any difficulty in finding subjects for future inquiries. It is far more doubtful whether the men possessing the qualifications which have been already indicated will be forthcoming. At first, if we are not mistaken, the choice will be very restricted, but each year will bring an accession of strength to the ranks of the competitors, so that if in the first instance the Company should be advised for want of suitable applicants to allow one or more of their scholarships to remain vacant, they will act wisely in delaying the appointment.

We do not think that the difficulty will arise, for the tide has already turned. Practical medicine, which has hitherto been strangely indifferent to the science on which it professes to be founded, is awakening to the importance of scientific investigation of the cause and nature of diseases. Among indications of the change may be mentioned the origin and successful progress of the new "Association for the Advancement of Medicine by Research," which has begun its function by devoting its funds to an inquiry into the etiology of tuberculosis. Another fact of equal moment as indicating the recognition of pathology as a special subject of study, is the intended establishment of a Professorship of the science in the University of Cambridge—an example which will no doubt soon be followed by the sister University. When this shall have been accomplished it may be hoped that the great educational institutions which are attached to Guy's, Bartholomew's, and St. Thomas's Hospitals may be also induced to follow the example of the Worshipful Company of Grocers, by doing something more than they have done hitherto to encourage and provide for "the making of exact researches into the causes of important diseases and the means whereby these causes may be prevented or obviated."

ELEMENTARY METEOROLOGY

Elementary Meteorology. By R. H. Scott, M.A., F.R.S., Secretary to the Meteorological Council. (London: Kegan Paul, Trench, and Co., 1883.)

MR. SCOTT'S aim in this text-book of meteorology is to explain the conditions required for the successful prosecution of the science, and to show in some detail the more prominent of the results which have already been arrived at. The various instruments are figured and described, and the methods of observing detailed at length; and emphasis is laid on the necessity of securing accurate observations, and of paying attention, in making arrangements for observing, to the few simple and obvious principles which underlie the science. An account is then given of the geographical distribution of temperature, pressure, and the other phenomena of meteorology, particularly those which are usually comprised under the heads of climate and weather. The book is a highly successful one, and evinces a full and ready knowledge of the work which has been done by the meteorologists of this and other countries down to the present time, and we must not omit to add that there is an earnest endeavour manifested throughout to give the fullest credit to the first discoverers of the more important facts and principles.

The following extracts, in explanation of hill and valley winds and the distribution of rain and weather on the two sides of a mountain-chain, show the general style of the book:—

"The day wind brings up moisture to the upper strata of the atmosphere, and this is condensed, forming caps on the mountain-tops, and often giving rise to thunderstorms. The night wind, a descending current, carries the moisture with it, and so the highest peaks are oftenest clear in the early morning. The reasons of this rhythmical change in air-motion are to be sought for in the action of heat. In the daytime the air in the valleys and on the lower slopes of the mountains becomes heated and expanded. The isobaric surfaces over such districts rise, and the air so raised has a tendency to flow towards the mountains and up the upper valleys as long as the heat action over the lowlands is maintained. At night the temperature in the valleys falls, and the air lying in them contracts, producing a partial vacuum. This causes the air above to descend, so that a downward current is generated, which lasts all through the night. . . .

"When wind coming in from the sea, and therefore charged with moisture, meets a mountain-chain, it is forced to rise; it is cooled by rising, and made to give up much of the vapour it brings with it in copious rains. The result is that the air is rendered dry and cold. If now the average height of the cols of the chain above the plain country beyond be 4000 feet, the air in its descent may receive an increment of temperature of over 20°·0, and as at the same time its capacity for containing moisture will be increased, it will be felt as a dry hot wind. This is the explanation of the characteristics of the Föhn of Switzerland."

This gives the true explanation of the increased humidity observed during the hottest hours of the day on the Faulhorn and similar elevated situations.

A long extract is given (pp. 269-275) from Laughton's "Physical Geography," summarising the broad features of atmospherical circulation as exemplified by the trades and anti-trades, in which it is stated that in both hemispheres to the north or south of the parallel of 30° or 40° a strong westerly wind blows with great constancy all round the world;—and that, alike in the Atlantic and Pacific; in North America, west of the Rocky Mountains; in the Eastern States; in European Russia and Germany, and in Northern Asia, there is found the same predominance of westerly winds. A more decided objection might have been made to the above view than by stating that the winds of the temperate zone and of the higher latitudes seem to be regulated by the distribution of pressure. Laughton's statement might possibly be accepted if we had before us little more than Horsburgh and the other directories of the navigator. In the north-west of Iceland observations show on the mean of the year 212 days when the wind blows from some easterly point, and only 71 days when it blows from any westerly point, and these prevailing winds of Iceland are essentially typical of the winds of an extensive region of the north. The cyclonic and anticyclonic systems of winds observed on the surface of the earth in connection with the well-known seasonal areas of low and high pressure are not merely surface winds, but extend to a considerable height in the atmosphere. This is evident from the consideration that in winter, pressure is 1·115 inch higher in Siberia than in Iceland, and in summer 0·860 inch higher in the Atlantic than in the south-west of the Punjaub in the same latitudes, and that great disturbances of the equilibrium of the atmosphere must necessarily obtain to very great heights. It therefore follows that over large portions of the northern hemisphere gradients for prevailing westerly winds cannot be formed within many thousand feet of the earth's surface.

Mohn's happy classification of thunderstorms into heat thunderstorms and cyclonic thunderstorms is adopted and illustrated. The former is the type which predominates in summer and in hot climates, while the latter are characteristic of our Atlantic coasts, Iceland, and Norway, and are a not infrequent accompaniment of cyclonic disturbances. Cyclonic thunderstorms have their maximum period in winter, and though they occur at all hours of the day, yet long-continued observations show a distinct diurnal period having the maximum during the night; and in some regions so strongly marked is this phase that, of the twenty-three cyclonic thunderstorms which occurred in Iceland in fourteen years, only three took place at an hour of the day when the sun was above the horizon. On the other hand, heat thunderstorms are most frequent during the hottest period of the day, or during the early afternoon.

Sheet lightning and the so-called summer or heat lightning are stated to be nothing else than the reflection of, or the illumination produced by, distant electrical discharges. This opinion, so long and generally entertained, is not supported by observation. At Oxford, during the twenty-four years ending 1876, the following are the number of times which thunder, with or without lightning, and lightning unaccompanied with thunder, have been recorded during May, June, July, and August, from 3 p.m. to 4 a.m.:—

	Thunder.	Lightning.		Thunder.	Lightning.
3-4 p.m.	17	0	10-11 p.m.	12	13
4-5 ,,	27	1	11-mid.	8	30
5-6 ,,	29	0	mid.-1 a.m.	7	27
6-7 ,,	21	0	1-2 ,,	11	27
7-8 ,,	21	2	2-3 ,,	12	10
8-9 ,,	8	1	3-4 ,,	3	3
9-10 ,,	7	7			

Thus at Oxford the hours of maximum occurrence of thunder is from 4 to 6 of the afternoon; but the hour of maximum occurrence of sheet lightning or heat lightning is delayed till about midnight. These different times, but above all the larger number of cases of heat lightning over thunder about midnight, which are nearly as 7 to 2, proves that a large proportion of these cases of heat lightning at Oxford were not the reflection of distant electrical discharges or thunderstorms, and this conclusion is amply confirmed by similar observations made in other parts of the globe. A very large number of these cases of sheet lightning at Oxford are, as suggested by Prof. Loomis in 1868, due to the escape of the electricity of the clouds in flashes so feeble that they produce no audible sound, and they occur when the air being very moist offers just sufficient resistance to the passage of the electricity to develop a feeble light.

SALVADORI'S PAPUAN ORNITHOLOGY

Ornitologia della Papuasia e delle Molucche, di Tommaso Salvadori. Parte terza. 4to. pp. 597. (Torino, 1882.)

THE completion of the third and concluding portion of Count Salvadori's great work upon the Birds of New Guinea and the adjoining Islands is an event that should be duly chronicled. We have already spoken of the plan of this great undertaking, and of the excellent way in which it has been carried out, in our notices of the preceding volumes (see NATURE, vol. xxiii. p. 240, and vol. xxiv. p. 603). We will now say a few words upon the general results arrived at.

The ground covered by the present work embraces, it must be recollected, the whole of the northern portion of the great Australian region. The mainland of this district is New Guinea, but it also contains the islands of the Moluccan Archipelago up to "Wallace's Line," besides various groups situated to the east and south-east of New Guinea, and extending as far as the Solomon Islands. In the "Papuan Sub-region," as it is generally called, thus constituted, it will be evident that variation must necessarily play a much more important part than in the solid continent of Australia. Not only do the species isolated in the different islands obtain a better chance for the exaggeration of their peculiarities (as has been so well shown by Mr. Wallace in his "Island Life"), but in the mainland of New Guinea we find mountains reaching to such an altitude as to cause the presence of a very different fauna from that of the adjoining lowlands. From these two causes it would be naturally expected that the ornithology of the Papuan Sub-region would be more rich in species than that of Australia proper. And such, indeed, is shown to be the case by the completion of Count Salvadori's work, whereby the first summary has been effected of the Papuan Ornis, since recent researches have revealed to us its luxuriance. In Mr. Gould's great work upon the Birds of Australia little more than 700 species of birds are given as inhabitants of the whole of that great continent. By Count Salvadori's volumes, we find that 1028 species are already known to us from the Papuan Sub-region, and, as we all know, a very large portion of New Guinea and many of the adjacent islands are still *terra incognita*. Much therefore remains to be added to the Papuan Avi-fauna, whilst in Australia the subject is comparatively exhausted.

Taking a general survey of the forms of Papuan bird life, we see at once how nearly akin it is to that of Australia. Recent researches especially have shown that nearly all the peculiar forms of the Australian Ornis have their representatives in the Papuan Sub-region. Some of these forms, however (for example, the Paradise-Birds and the Cassowaries), are much better represented in the Papuan Islands than on the Australian Continent, and the Papuan Islands must be regarded as their original home, whence they have sent forth stragglers into the Southern Continent.

Such general facts as regards the distribution of bird life in the Australian Region may be easily gathered from an inspection of the contents of the present work. But our author, we are glad to see, promises us to put them forward in his own shape, in an "Introduction to the Ornithology of Papuasia and the Moluccas," which he is now preparing. In this supplementary volume will be likewise given chapters on the history and bibliography of the subject, and a chart to illustrate its somewhat complicated geography. Count Salvadori is evidently determined to spare no trouble in order to render complete the results of his eight years' hard labour on the Birds of Papuasia and the Moluccas.

OUR BOOK SHELF

Cutting Tools Worked by Hand and Machine. By Robert H. Smith, M.I.M.E. (London: Cassell, Petter, Galpin, and Co., 1882.)

STUDENTS of mechanical engineering, and more especially those who study machine tool construction, have up to the present time found it very hard to obtain a suitable text-book relating to the theoretical part of the subject; hitherto almost the only books relating to it have been published in Germany.

This work comes to hand at a time when the want of such a work is much felt, and students attending mechanical engineering classes will find that it will help them considerably in understanding the construction, theoretically and practically, of the machines dealt with. The author in his preface states distinctly that he does not intend the book to be a descriptive treatise on tools, nor does he refer to all the different cutting tools in use, but he has happily chosen the more important machines, and gives a very full description and illustration of each. The subject of driving power is dealt with and fully explained, and results of experiments carried out by the author on the subject are carefully arranged in tables.

In the first chapters cutting tools for wood are discussed, the wedge action of any cutting tool being clearly described and illustrated; also the method of grinding and setting edge tools, frequently a very difficult task for beginners to accomplish. He also gives the results of experiments carried out by himself on the power required to be exerted through certain tools when doing a fixed amount of work, an interesting subject from a theoretical point of view.

The chapter on chipping-chisels and hand-planes fully explains the action and construction of the several tools, the different angles of the cutting-edge of cold chisels are shown, and the author points out the reasons for varying the angle according to the quality of the metal. The whole chapter goes into the subject practically, the explanations being clear and to the point. The next chapters deal more especially with wood-working machinery. The variety of teeth used in the different kinds of saws, including inserted teeth, are amply illustrated, the important matter of setting the teeth being fully explained, with experiments showing the power absorbed in driving the different saws, this also being usefully arranged in tables; after which the author goes on to explain the different machines used in working the metals, milling machinery having its full share of the text. The cutting speed and rate of feed for milling-cutters is gone into, and in the latter part of the chapter the milling-cutters themselves are dealt with.

Chapter V. relates to the various methods of planing metals, and concludes by dealing with the behaviour and action of the larger machine tools, including planing, shaping, and slotting machines, all of which are illustrated.

The following chapters go fully and minutely into the construction and working of the lathe, perhaps the most important of all the machines in a workshop; describe its various uses, both for hand-turning and wood, and the mechanical slide-rest for metals. A screw-cutting and surfacing lathe is illustrated, and all its different motions explained. It is impossible here to do justice to these chapters on the lathe and turning in general. The student will find the time well employed if he studies them carefully, the author evidently being well acquainted with the practical working of this all-important machine.

The remaining chapters are occupied with drilling, boring, and the necessary machines for carrying out the same; a variety of drills are shown, and their different uses explained. The drilling machine, its construction, and various arrangements of feed gear are illustrated and concisely shown.

The book concludes with shearing and punching machines. Various illustrations are given, including Whitworth's driving gear for the same, and an illustration of Tweddle's hydraulic shearing and punching machine.

As a treatise on cutting-tools, for wood and iron, this work will be found extremely useful to engineers generally; moreover, there is a good deal of original information that will be found interesting to experienced toolmakers. The classification of the machinery is decidedly good, and the descriptions are so simple as to be easily understood by the uninitiated. It is impossible to study the book without at once finding that the author is completely master of his subject. Of course there is no doubt that practical working is essential to perfection in any branch of engineering; yet the student who is unable to attain such practical knowledge will obtain a good insight into the construction and the uses of the various machines and tools in their connection.

The author certainly seems to have omitted a matter of great importance in tool-making, namely, that of tempering and hardening the cutting-tools. There is little doubt that most of the failures arising in wood and iron-working machinery are due to tools not being properly hardened. A chapter or two devoted to the subject would have been of great service.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Metamorphic Origin of Granite.—Prehistoric "Giants"

I HAVE for some time intended to send you a few notes on two matters, both connected with geology, though very different in kind. In NATURE, vol. xxvii. p. 121, there was an interesting paper by Mr. Geikie on the metamorphic origin of granite and on the crystalline schists. Last autumn I became satisfied of a conclusion which I had long suspected—that the large granitic district in the Ross of Mull, adjacent to the Island of Iona, is a great mass of granite formed by the metamorphism of an old stratified deposit belonging to crystalline schists. It is well known to geologists that the Isle of Mull consists almost entirely of the series of (Tertiary) volcanic rocks which have been admirably described by Prof. Judd. These traps, tuffs, and lavas rest in some places on chalk, and where the chalk had been previously denuded they rest on Oolitic and Liassic beds. Older rocks, belonging, I think, to the Cambrian series, appear at one place subjacent to the traps. But the limit of all these volcanic rocks to the south-west is sharply defined by the deep bay and harbour of Bunessan, called Loch Laigh. As we enter that loch in a boat, we have on our left the trap headland of Ardtun, where I found the Tertiary leaf-bed many years ago, and on the right a headland of massive red granite. But the shores at the end or head of the bay, including all the hills above the village of Bunessan, are neither trap nor granite, but are composed of the regular crystalline mica schists which constitute the great bulk of the county of Argyll. This is the only part of Mull, so far as I know, where these rocks appear. They stretch right across the long promontory of the Ross to the southern shore. At the head of Loch Laigh they are more highly crystalline than in most parts of the mainland of the county. Very fine crystals of tourmaline have been found above Bunessan, and the schists near the new pier are highly micaceous and in some places full of coarse garnets. These schists dip at a high angle, and indeed are in some places nearly perpendicular. On the southern coast of the promontory (which is here very narrow) they occupy a considerable space between the traps which terminate on the farm of Scoor, and the granite which begins on the farm of Ardalanish. The point of contact between these schists and the granite is obscured at the head of Loch Laigh, and I have not visited it on the southern shore. But the point of most interest will be found in the granitic headland which forms the south-western shore of Loch Laigh. Along part of this shore the granitic masses at the top of the hill have all the appearance of standing upon legs. These legs at a little distance seem granitic, and although they have a suspicious appearance of tilted strata, I had passed them over and over again under a general impression that they were nothing but granite divided by unusually narrow lines of cleavage. On examining them, however, carefully, in August, 1882, I found that they are (in my judgment) beyond all doubt crystalline bedded schists exhibiting the phenomena of metamorphism in the most curious and instructive form. The metamorphic action has often segregated the mineral constituents of the old sedimentary rock in bands transverse to the line of bedding, so that in one stratum we have bands of pure quartzite and of hornblende gneiss, between bands of granitoid and of pure granitic composition. These beds pass up without a break into the amorphous granite of the great bulk of the hill; and how pure and typical that granite will be acknowledged when I add that the columns of the memorial to the Prince Consort in Hyde Park are made of it. Since discovering this passage I have found some other spots on the coast where the relation of the two rocks to each other is well seen. The best is on the deeply indented shore of the farm of *Knockvoligan*, behind the Island of "Gilan Giraid," on which the Northern Light Commissioners have placed their establishment in the Sound of Iona. Boats can be hired at Iona, and at high tide there is a beautiful passage behind Gilan Giraid to the shore I refer to. There a dark hornblendic gneiss will be seen underlying, involved in, and passing into granite in every form of complication and variety. An interesting question arises as to the horizon to which this hornblendic rock belongs. As Iona belongs unquestionably, as I believe, to the Laurentian series, and the Bunessan schists to the metamorphosed Silurian, the sub-granite gneiss which intervenes may be assigned to either the one or the other. My impression is that it represents some of those gneissose beds of the Silurian series which are highly developed in Sutherland, and lie high above the "fundamental" or Laurentian gneiss, so well known in that county. I should be very glad if some competent geologist could investigate this district of the Ross of Mull, and could confirm or check my observations.

Turning now to the other subject. I have been surprised to see in the English scientific journals no notice taken of the very remarkable discovery reported from the Californian Academy of Science in a paper communicated to that body by Charles Drayton Gibbs, C.E., on the discovery of a great number of (apparently) human footprints of a gigantic size in the State of Nevada. It appears that in building the State Prison, near Carson City, the capital of that State, there was occasion to cut into a rock composed of alternate layers of sandstone and clay.

On several of the clay floors exposed in this operation great numbers of tracks of all sorts of animals have been exposed. These tracks include footprints of the mammoth or of some animal like it, of some smaller quadrupeds apparently canine and feline, and of numerous birds. Associated with these are repeated tracks of footsteps, which all who have seen are agreed can be the footsteps of no other animal than man, and the engravings and photographs which accompany the paper leave no doubt on the mind of any one who sees them. The most remarkable circumstance characterising them is their great size. In one case there are thirteen footprints measuring 19 inches in length by 8 inches wide at the ball, and 6 inches at the heel. In another case the footprints are 21 inches long by 7 inches wide. There are others of a smaller size, possibly those of women. One track has fourteen footprints 18 inches long. The distance between the footprints constituting a "step" varies from 3 feet 3 inches to 2 feet 3 inches and 2 feet 8 inches, whilst the distance between the consecutive prints of the *same foot* constituting a "pace" varies from 6 feet 6 inches to 4 feet 6 inches. In none of the footprints of the deposit are the toes or claws of animals marked. As regards the beasts, this is probably due to the "slushy" state of the mud when the tracks were made. But in the case of the human footprints it is probably due to the use of some kind of shoe or mocassin.

I need not say that so far as the geological horizon is concerned this discovery does not carry the existence of man beyond the Quaternary Mammalia, with which it has long been pretty clear that he was associated in prehistoric times. Nevertheless it is, if confirmed, a highly remarkable discovery, especially as connected with the curious intimation so concisely made in the Jewish Scriptures, "And there were giants in those days." Hitherto, so far as I know, the remains of prehistoric man, so far as hitherto discovered, have not revealed anything abnormal in point of size. It is just possible that the slippery and yielding nature of the muddy lacustrine shore on which the tracks were made may have partly occasioned the apparent size. But the photographs and engravings exhibit them as very sharp and "clean cut." Professional Indian trackers have been employed to examine the tracks, and none of them seem to have the smallest doubt as to the footprints being human. ARGYLL

Cannes, April 14

P.S.—The paper was sent to me by my son, the Governor-General of Canada, a few weeks ago.

"The Ether and its Functions"

IN NATURE, vol. xxvii. pp. 304, 328, is a reprint of a lecture delivered by Dr. Oliver Lodge in December 28, 1882, at the London Institution, on "The Ether and its Functions." As this happens to be a subject to which I have devoted special attention, I would beg to offer a few remarks, also as my name is alluded to in the article.

The repudiation of the assumption of "action at a distance" in the first part of the lecture, coupled with the ingenious arguments by which its baselessness is exhibited, will no doubt be encouraging to all those who favour the advance of knowledge. But that portion of the lecture dealing with the constitution of the ether (and which assumes it to be non-molecular) is to my mind disappointing, as it looks like a step backwards to suppose the ether to be something essentially different from ordinary matter, while on all sides the simple opinion of the "unity of matter" has been making progress. I will quote the passage more especially relating to this point, viz. :—

"As far as we know, it (the ether) appears to be a perfectly homogeneous incompressible continuous body, incapable of being resolved into simple elements or atoms; it is in fact continuous, not molecular. There is no other body of which we can say this, and hence the properties of ether must be somewhat different from those of ordinary matter" (p. 305).

It will be admitted that clearness is a first desideratum in a theory. It appears difficult to see how an "*incompressible*" body is to transmit waves.[1] A remark of Maxwell's in his paper "On the Dynamical Theory of Gases" has some bearing on this point, viz. : "The properties of a body supposed to be a uniform plenum [*i.e.* not molecular] may be affirmed dogmatically, but cannot be explained mathematically" (*Phil. Trans.*, 1867, p. 49). Moreover, it seems hard to reconcile the fact that Sir W. Thomson's theory of the constitution of matter is apparently adopted or favoured in the lecture, and yet at the same time the molecular or atomic nature of the ether is repudiated. But is not Sir W. Thomson's theory of matter essentially an atomic theory? The incompressible fluid outside the vortex atoms cannot serve as the ether, or this seems an impossibility. Maxwell, for example, remarks in relation to this point, viz. : "The primitive fluid [*i.e.* the fluid exterior to the atoms] entirely eludes our perceptions"[1] (see "Encyc. Brit.," article "Atom," p. 45). The ether, however, does not entirely elude our perceptions, but is very distinctly felt in the beating of the waves of light upon the eye. It appears, therefore, that if the ether is to affect the senses at all it must consist of atoms or molecules (doubtless very much smaller than those of gross matter, a difference in *degree* but not a difference in *kind*). It may be noted in passing here how often notoriously has the error of mistaking a mere difference in *degree* for a difference in *kind or essence* been made in the history of science, and the correction of this error with the correlation and simplication of views attendant on its removal marks one of the chief stages of our progress. The theory of evolution abolished this error in regard to the animal world; its abolition in regard to the universe of matter is equally demanded. One satisfaction that Sir W. Thomson's theory of matter brings, consists perhaps in the fact that it does not overthrow our old conceptions as to the atomic constitution of matter so firmly built up by the able reasoners of the past, including Lucretius and Newton—and which has produced such great results for science. The Thomsonian view goes rather to confirm the atomic theory and to establish its truth by explaining in addition how an atom can be *elastic* and yet indestructible. Let us not deviate from the well-tried ground of the atomic constitution of matter, already won with so much labour, unless we are forced to do so, and let us work towards the great generalisation of the Unity of Matter and of Energy.

London, April S. TOLVER PRESTON

P.S.—My views regarding the Matter of Space (the result of many years of thought and study) are contained in various scattered papers, references to the chief of which may be conveniently given here, viz. *Philosophical Magazine*, September and November, 1877, February, 1878; NATURE, January 15,[2] 1880; March 17, 1881; March 20, 1879; *Philosophical Magazine*, August, 1879, November, 1880; April and May, 1880, &c., &c. Also a little book, "Physics of the Ether" (E. and F. N. Spon), was published in 1875 as a first imperfect essay on the subject. The above papers include an atomic theory of the ether, capable of affording a simple and natural explanation of gravitation without the aid of "ultramundane corpuscules" [*i.e.* without the supply of any energy or matter at all from outside the bounds of the visible universe]. Dr. Lodge seems to admit that his premises cannot explain gravitation. But is not the elucidation of gravitation (which may be called the primary physical effect in the universe) one of the first requirements of any theory of the constitution of the Matter of Space? A more concise summary of my views (with additions and developments, the work of recent years) regarding the relations of the Matter of Space to ordinary matter and to the local fluctuating changes taking place in the universe, may be found in the forthcoming volume of the *Transactions of the Vienna Academy of Sciences*, to which they have been communicated by Prof. Ludwig Boltzmann of Graz.

[1] For it seems apparent that an incompressible, non-molecular, "frictionless" liquid could not have wave-energy imparted to it at all, or a hot substance could not emit light or heat in such a medium. Moreover let us (in a spirit of fair argument) take a representation of one of the most commonplace effects in physics, say an explosion of gunpowder. Then the assumption of "action at a distance" being rejected, there is (admittedly) no more playful building of castles in the air out of "force," or no store of phantom energy to get the motion ("explosion") from. The motion therefore must inevitably come from the matter of space, or from a set of particles or atoms already in motion in space in their normal state. How is a non-molecular, *frictionless* liquid to lay hold (as it were) or act upon the molecules of gunpowder and put them in motion? Is not the objection conclusive though elementary?

[1] A clear and able exposition of the relation of Sir W. Thomson's theory of matter to the old-established atomic theory may be found in a paper on "The Atomic Theory of Lucretius," by an anonymous author in the *North British Review* for March, 1868.

[2] This paper includes a corpuscular theory of light consistent with the main principles of the undulatory theory—*not* therefore an *emission* theory.

"Krao"

SOME two months ago there appeared in NATURE (vol. xxvii. p. 245) certain statements about "Krao," the Siamese hairy child, which with your leave I would venture to correct. Krao's parents are both Siamese, not Laos; they are both still living in this city; neither of them presents any special peculiarity; they have other children still living, and also showing no special peculiarities; Krao, it is true, was not born in Bangkok, but in a village between this and the sea, her parents having a little time before her birth run away from their master, but coming back after the event. Siamese is of course Krao's native language;

in her short journey up country with Mr. Bock, she, being an intelligent child, picked up a few words of Laos; the joints of her arms and fingers possess, it is true, according to European ideas great flexibility, but really they have it to no greater degree than those of ordinary Siamese; it is also true that she is able to use her toes, grasping things between the big toe and the next one in a way that is surprising and amusing to Europeans, but this is a faculty which all Siamese, being a barefooted people, possess to a greater or less degree; the child was looked upon here as even a greater natural curiosity than she is considered to be in England, her parents being in the habit of taking her about and showing her for a small reward, and the price they obtained for her (in native currency equal to 60*l.*) being twice that of an ordinary child of the same age. A strange mistake has been made about the child's name, "Krao" being merely the Siamese name for whiskers, a very natural nickname for the child to obtain. As far as I can ascertain from those who knew the child well, she is endowed with the average intelligence of Siamese children of her age and class, and beyond her abnormal hairiness presents no peculiarity.

To sum up, "she is," as you rightly remarked, "merely a *lusus naturæ*, or a sport, possessed rather of a pathological than an anthropological interest. I may add that I have carefully verified all the foregoing statements. A RESIDENT

Bangkok, Siam, March 3

[From information that has since reached me I am able fully to confirm the particulars here supplied by "A Resident."—A. H. K.]

Singing, Speaking, and Stammering

IN NATURE, vol. xxvii. p. 532, in the report of Dr. Stone's lecture on "Singing, Speaking, and Stammering," there appears a *Classification of Vowels*, which is described as an abstract of Mr. Melville Bell's scheme. I should like, however, to point out that the system which Mr. Bell has advocated for the last fifteen years is hardly represented in the *Classification* referred to. On turning to p. 63 of Mr. Bell's "Sounds and their Relations," which is a new exposition of "Visible Speech," it will be seen that the vowels *Ir* and *Ah* are not described as labio-lingual, and that the threefold arrangement of the vowels as lingual, labio-lingual, and labial is abandoned as incorrect. The lecturer does not appear to have mentioned the phonetic researches of Mr. A. J. Ellis and Mr. Henry Sweet. In many important points, however, they supplement the system of Mr. Bell, and their works cannot be overlooked in the scientific study either of etymology or pronunciation. The student of language can hardly do better than begin with Mr. Ellis's "Speech in Song," and Mr. Sweet's "Handbook of Phonetics." JAMES LECKY

5, Alexandra Road, Wimbledon, S.W., April 10

THE classification of vowels to which Mr. Lecky refers is taken from Mr. Melville Bell's "Principles of Elocution," which I obtained with much difficulty from a publisher in Salem, Massachusetts. It is dated 1878, and may, I suppose, be held to represent the author's system at that date. I am well acquainted with the other works named by Mr. Lecky. W. H. STONE

AS an illustrative instance of the peculiarities akin to stammering, referred to in Mr. Stone's lecture in last week's NATURE (p. 559), I may mention the case of an old Scotch lady whom I knew some years ago, and who was in the habit of interpolating at frequent intervals in her talk the wholly irrelevant words "This that here there ye ken." She herself evidently made use of the words with perfect unconsciousness of their irrelevancy; indeed I doubt whether, if challenged, she would have admitted using them at all. K.

A Curious Case of Ignition

"A CURIOUS case of ignition," quoted in NATURE, vol. xxvii. p. 509, reminds me of a similar circumstance that came under my own observation when serving in H.M. despatch vessel *Psyche*, 1862–66. We were moored "head and stern" in Port Napoleon, Marseilles, on a bright summer day. A strong smell of burning was traced to the saloon skylight. On bursting open the door of the saloon it was found that a scuttle glass (a plano-convex lens) through which the solar rays were admitted and focused on a rep curtain (which was smouldering) had been substituted for a broken one, but through an oversight had not been ground on the plane surface (as is usual). The case was reported by letter, and an order issued to insure all scuttle glasses used in men-of-war for the purpose being ground. BERTRAM GWYNNE

Fibreballs

I HAVE seen balls of vegetable fibre, such as those referred to by Mr. G. H. Darwin in his letter of March 23 (NATURE, vol. xxvii. p. 507), in great abundance on the sea-beach at Cannes; there however they are not spherical like those described by Sir A. Musgrave, but cylindrical, two or three inches in length, finely and closely matted, and all wonderfully similar in appearance. In one place they had been collected and employed, if I remember rightly, to form a kind of wall. Some balls of a similar kind, but more nearly spherical and much coarser in texture, were found, on draining a pond, by Dr. Fitton, and sent by him to Sir J. Herschel, these were three or four inches across, and looked almost like small hedgehogs rolled up. J. H.

Benevolence in Animals

MR. GEO. J. ROMANES, in a lecture delivered in Manchester, March 12, 1879, on "Animal Intelligence," points out the following emotions which resemble human intelligence as occurring in animals below the human species, namely: fear, affection, passionateness, pugnacity, jealousy, sympathy, pride, reverence, emulation, shame, hate, curiosity, revenge, cruelty, emotion of the ludicrous, and emotion of the beautiful, and gives some remarkable instances in support of his statement. To this I can add benevolence on the part of our household cat, who was observed to take out some fish bones from the house to the garden, and, being followed, was seen to have placed them in front of a miserably thin and evidently hungry stranger cat, who was devouring them; not satisfied with that, our cat returned, procured a fresh supply, and repeated its charitable offer, which was apparently as gratefully accepted. This act of benevolence over, our cat returned to its customary dining-place, the scullery, and ate its own dinner off the remainder of the bones, no doubt with additional zest. OSWALD FITCH

Woodend, Fortis Green, N., April 12

The Zodiacal Light (?)

LAST Friday evening about 7 p.m. my attention was called to a peculiar appearance in the western sky. The sun had set not long before. No clouds were visible but one long thin streak, and there were the usual mists near the horizon. Above where the sun might be, a pillar of light faintly red in colour, with soft edges, but fairly well defined, rose vertically from near the horizon to the height of perhaps a few degrees. It did not look like an illuminated cloud nor like rays of light shot up through a cloud, nor like anything local; in fact I am told that it moved northwards with the sun. Was this the zodiacal light, or merely some sunset effect? It began to grow dim about 7.10 p.m, but was visible later than this. J. W. B.

New Kingswood School, Lansdown, Bath, April 10

Braces or Waistband?

THE writer has for the last thirty years dispensed with the use of either braces or a belt, having had his waistcoats made with short elastic straps attached inside and with holes to button on to the trousers like braces, one on each side and a third in front.

They answer as well as braces in conjunction with the ordinary waistband and buckle of the trousers, and the wearer is saved the feeling of strain across the shoulders or round the waist connected with the use of braces or a belt. G. H.

April 13

THE TEACHING OF ELEMENTARY MECHANICS[1]

AT the recent Annual Meeting of the Association for the Improvement of Geometrical Teaching held, as has already been noted in our columns, at University

[1] Association for the Improvement of Geometrical Teaching, Ninth General Report, January, 1883.

College, on January 17, the following statements of work done by the Committees were presented. In *Solid Geometry* no progress had been made in consequence of the serious illness of the secretary (Mr. Merrifield), but the President in his subsequent address remarked that it was hoped that the Committee would meet at an early date and work out, upon the basis of what Mr. Merrifield had done, a syllabus of propositions corresponding to the 11th and 12th Books of Euclid and the simpler geometry of the sphere. In *Higher Plane Geometry* the Committee had revised about half of the syllabus issued in 1879 and had added chapters on the geometry of the triangle and on geometrical maxima and minima (copies were distributed amongst the members present, and have been subsequently circulated). In *Geometrical Conics* the former syllabus had also been revised and continued to the end of the hyperbola (this syllabus is also in the hands of members). In *Elementary Plane Geometry* the proofs of Book I. of the *Syllabus* had been revised, the proofs of Book II. drawn up, and a collection of Exercises on Books I. and II. had been added (the motion in connection with the adoption of these proofs, which was down in the President's name, had to be postponed in consequence of copies not having been circulated before the meeting).[1] Gratifying testimony to the success of the Association's efforts was afforded by the fact recorded in the Council's Report that the copies of the syllabus were all disposed of, and that it was in contemplation to bring out at once a revised edition of the work in accordance with the changes made in the books of proofs.

In addition to the usual routine business, the President closed the morning sitting with some remarks on the teaching of arithmetic. This is a subject the claims of which upon teachers he has at many previous meetings pressed upon his hearers, it being his desire that the teaching should be put upon a sounder footing than it at present in most cases occupies. A true disciple of his old master, De Morgan, he insisted strongly upon the more frequent appeal to reason than to rule. "It seemed to him to be the wrong order to give first the rule and then the reason. Teachers should take particular examples, and work them out with reasons for every step. They should lead up to a rule by a series of examples worked out from common sense, and only when these have been thoroughly grasped should the rule be introduced as a convenient embodiment and summing up of the results attained by the application of reason and common sense." A common habit with boys is to ask, "How am I to do this?" "In his own practice he never answered that question, but he said, 'What does it mean? If you will only find out what it means, then you will know how to do it.'" Another principle he advocated was "that all arithmetical processes should follow the order of thought, according to which numbers are grouped in language. . . . . The order of thought in the expression of numbers was from the higher group to the lower, hundreds to tens, tens to units, &c." In this connection he referred to a lecture by the late Mr. Bidder. A reform on the principles he (the President) advocated would, he believed, be very valuable in teaching and in the practical operations of arithmetic. In the natural sciences arithmetic is applied to cases where approximate data only are employed. "Hence it was becoming more and more important that methods of approximation should be carefully and distinctly taught." This led him to enter a protest against the practice, frequent amongst University examiners, of setting in papers for schoolboys, "among the questions on decimal fractions, some examples to be done only by reducing recurring decimals to vulgar fractions, and then working out the result by vulgar fractions. To give prominence to such examples was simply to destroy the notion which a good teacher would have been endeavouring to instil into a boy's mind, that decimal fractions are useful only in general for approximate results. He did not wish to say anything against recurring decimals rightly used and in their proper place." A final point was that he would substitute Horner's process for the extraction of any roots for "the awkward and almost useless special processes usually given for extracting square and cube roots. This he would teach simply as a process; but of course with fair warning to the boy by telling him that he was for once giving him a process which would lead to the desired result, and that it would be a reward of his future mathematical attainments if he could get to the reason of it."

The novel feature, however, in this year's proceedings was the holding of an afternoon sitting, which was wholly devoted to the consideration of the subject of elementary mechanics. This meeting was the outcome of the recent extension of the Association's sphere of action, and proved to demonstration that the said extension had met with the approval of many of our most able physicists. The papers read were three in number: (1) The Teaching of Elementary Mechanics, by Mr. W. H. Besant, F.R.S.; (2) Notes on the Teaching of Elementary Dynamics, by Prof. G. M. Minchin; (3) The Basis of Statics, by Prof. H. Lamb of the University of Adelaide. (1) is remarkable as proceeding from a successful Cambridge "coach," who finds it difficult to emancipate himself "from the ideas and prejudices which are the natural results of an adherence for many years to a special set of books and to a special system of teaching. The fact constantly before us in Cambridge, that mechanics are being studied with a view to success in examinations, tends to make us forget the importance of the practical application to daily life of a knowledge of mechanics, and the temptation is to luxuriate in the flowery and ornamental problems which sometimes form the staple of examination questions," whereas "millions of people must acquire a knowledge of the laws of mechanics, practical or theoretical, or both, who are not going to be tested by a Cambridge examination." It however goes without saying that at present Cambridge methods do exercise a very large influence on the teaching of mechanics throughout the country. In the case of young students and beginners, Mr. Besant considers that the first requisite for a class-room is a set of models and a quantity of machinery (*segnius irritant animos*, &c.). "The handling of systems of pulleys, and experiments with levers and screws, will guide the student, almost unconsciously, to the ideas of the transmission of motions, and of the transmission and multiplication of force. . . . Then, again, experiments with falling bodies, and with an Attwood's machine, will illustrate the ideas of uniform motion and of accelerated motion, and generally of the action of gravity. . . . For many students this kind of experimental teaching will probably be sufficient for the work of their lives, and it will be certainly educationally useful." The Cambridge practice has been to treat the subjects of statics and dynamics separately, and to take statics first; and the teaching is so limited that the ordinary Bachelor of Arts, whose reading has been limited to statics alone, "is sent out into the world without any perception of the laws of motion, and without any knowledge of the elementary deductions from those laws, which are necessary requisites for a true appreciation of a vast range of natural phenomena." Passing next in review the change of nomenclature and of treatment inaugurated by Professors Thomson and Tait, and the late Prof. Clerk Maxwell, Mr. Besant records his opinion that Duchayla's proof is "forced and unnatural," and causes a considerable waste of time. His wish is that the examiners should have greater freedom of action. He would, following the lead of the above-named eminent physicists, commence with a study of the

[1] A special meeting for the purpose of considering the postponed motion was held at University College on the evening of March 20, at which the "proofs" were adopted and their publication sanctioned.

elementary parts of kinematics, to include "the ideas and measures of velocity and acceleration, the parallelogram of velocities, and the parallelogram of accelerations, the motion of a point with a constant acceleration, and the acceleration of a point moving uniformly in a circle." Then would come "falling bodies and projectiles." From these particular cases the student will get a general idea of the action of force, and so be prepared for a study of the laws of motion, and of the deductions from these laws. "One of the first of these is the parallelogram of forces, and I am convinced by actual experiment of the ease with which that mode of proof is appreciated by a beginner. The perception of the physical independence of forces, which is really the qualitative part of the second law of motion, is not a serious difficulty to the majority of beginners in mechanics, and from this principle, with the aid of the parallelogram of velocities, the parallelogram of forces is developed easily and naturally." Next may be taken the mechanical powers and simple cases of equilibrium of bodies and systems of rods, a statement of the laws of friction, and the determination of the centres of gravity of bodies and systems. Mr. Besant also laid great stress upon graphical modes of solution, referring to Mr. Minchin's work on Statics for numerous examples in these methods. "The discussion of the theory of moments of forces would naturally lead up to the idea of a couple and to the transformation and composition of couples." The pupil might then proceed to the impact of balls on each other: "The easiest method for every one . . . is to assume the invariability of momentum, and the constancy of the ratio of the relative velocities before and after impact. The consideration of the action of the forces of compression and of restitution is a more difficult idea, and should be deferred to a later stage of the student's progress. In the discussion of these points the idea of work and of kinetic and potential energy may be introduced and illustrated, gradually leading up to the statement of the general principle of energy." Dwelling upon the wonderful results that accompany the employment of this general principle, "the very concentrated essence of science," which in elementary mechanics "widens the path and shortens the road, and reduces to simple forms of thought many problems which used to be reckoned as belonging to advanced regions of the higher mechanics, and as depending for their solution on the complicated machinery of analytical process," the paper alluded to the fact that it was only as recently as 1877 that this principle of energy appeared in Part I. of the Tripos Examination—a result mainly to be attributed, we believe, to Prof. Clerk Maxwell's advocacy of it. The principle is carefully laid down and discussed in "On Matter and Motion," as well as elaborately discussed in Thomson and Tait's "Natural Philosophy," and in many recent elementary treatises. With such views of its importance, we are not surprised to find Mr. Besant pleading for the introduction of the idea of energy as early as possible, and that every effort should be made to "illustrate the idea by means of simple cases and so to lead the student upwards, by gradual steps, to the conception of the most important principle which lies at the root of all modern science." Another point on which the paper touches is that "ill-chosen technical terms are likely to propagate erroneous ideas and confusion of thought," and reference is made to recent remarks on the use of the word "force." Then coming to the question of a syllabus of mechanics, Mr. Besant remarks that "it will be a matter of supreme importance to discuss the definitions and axioms of the subject," and instances a common definition of the word "vertical"—that it is the line in which a stone moves when let fall. The paper closes with a few general remarks on the value of some branches of scientific study as an education, from which we select the two following extracts:—"The safest and wisest plan seems to be to let every man, who wishes to make research in physics, find out for himself the kinds of tools which he wants, and then learn as much of the use of those tools as may be necessary." "The elementary subjects, such as mechanics and astronomy, are of more educational value to the majority of students than the higher regions of science, and only a select few should be encouraged to spend much of their time in such advanced forms of study."

(2) In this dynamics includes both statics and kinetics. The writer is in favour of continuing the old way of taking statics first, and of then proceeding to kinetics, and argues strongly against the taking the former as a particular case of the latter. Two important advantages, however, of the recent mode of treatment are not ignored, viz. that the student by concentrating his attention on force solely as change of motion, it at once proves for him the fundamental proposition of dynamics, viz. that of the "parallelogram of forces," as an immediate result of the easily admitted parallelogram of velocities ("if for the beginner the choice lay between such proofs as Duchayla's, and none, I should say, 'Assume the proposition'"); and next that "the kinetical method has the very great practical advantage that it makes the student familiar at the outset with the idea of *absolute measures* of force, momentum, energy, &c., such as are used in the C.G.S. system." The notion of *acceleration* is an exceedingly difficult one for beginners, and such a one, as a matter of fact, "is confined to the consideration of acceleration of constant magnitude, and, except in the case of uniform motion in a circle, to the case of acceleration in a constant direction. Thus he gets plenty of exercise in the motion of particles down inclined planes, ... but what idea does our beginner obtain of the acceleration of the motion of a particle revolving uniformly in a circle? Is there not something *primâ facie* very difficult, if not absurd, to him in the statement that any motion which takes place with *uniform velocity* can be accompanied by *acceleration?*" After a few more remarks to the same end, Prof. Minchin says, "So far as my own work in teaching is concerned, I have not a moment's hesitation in saying that the treatment first of kinetics and then of statics as a particular case is to be rejected. So difficult for the mere beginner are the conceptions involved in Newton's second axiom, that three months' work in combating difficulties and removing false impressions would, almost to a certainty, produce a merely negligible amount of positive knowledge." Starting from the kinetical definition of force, and thereby establishing the fundamental proposition ("this does not logically compel us to continue to treat of motion, deducing rest as a particular case"), the writer, after protesting against the too great importance attached to the getting-up of "book-work,"[1] expresses the opinion that the student realises the subject only by incessant application of the principles to particular cases. For this purpose nothing, he believes, is so good as *numerical examples:* and this in contrast to examples dealing with magnitudes as algebraical symbols, and to geometrical examples. "So long as forces are X, Y, Z, and moments are L, M, N, and no particular consideration of the *units* of different quantities is required, they are comfortable enough, but when we have to deal with pounds and foot-pounds, dynes and ergs, the utter unavailability and inutility of their knowledge are made manifest." Another point strongly insisted upon is *the invariable accompaniment of figures constructed accurately to scale with all the examples.* The result should be arrived at by calculations made by means of logarithmic and trigonometrical tables, and also by graphic construction by the aid of the instruments, and on all there should be, when possible, "the perpetual

[1] "I have met students who could write out paragraph after paragraph of general propositions in statics, and who at the same time (although such might appear to *a priori* reasoners impossible) could not make the faintest attempt to discuss any particular question involving the application of the principles of statics."

exercise of a *common-sense check.*" Too much weight may be attached to *graphic statics*, "but real utility is gained by making graphic methods a companion to (though not wholly a substitute for) analysis," and Prof. Minchin would assign a more conspicuous place to them in the text-books than they at present occupy. "Their essential merit consists in their furnishing visibly to the student the whole history of a magnitude throughout a series of variations in its circumstances." Prof. Minchin would also banish such "crude" terms as "power," "weight," in the equilibrium of machines: such forces might be called "efforts" and "resistances." Passing over one or two other subjects, we come to remarks on "illogical methods of teaching"; by such a method is here meant *a process which introduces considerations that are not essentially necessary for the purpose aimed at—considerations that can be seen a priori* to be *irrelevant.* The moral is pointed by the discussion of a question of usual occurrence in the text-books. The student should be able to be *critic of his data*, and "he ought to be taught to recognise clearly the object finally aimed at in any problem, and also to see what he must be given, and what he need not be given, in order to arrive at it." For this purpose Prof. Minchin purposely uses with his students some books which, *both in their data and in their methods*, are full of illogicisms. The finale comes in pointing out the desirability of making the student carefully distinguish between the *weight* of a body and its *mass*, and here he "comes down," if we mistake not, on an episcopal writer of works on dynamics, for a "remarkable misuse of language."

(3) Prof. Lamb's object is to suggest a new basis for the science of statics, and in the course of his paper he attacks certain principles and artifices, as "the transmissibility of force," and (in hydrostatics) the solidification of matter, and also "rigid" bodies. The "point of departure" which he suggests is that "the true and proper basis of statics is to be sought for in the principle of linear and angular momentum. Regarding statics as the doctrine of the equivalence of forces, I would define the word 'equivalent,' and say that two sets of forces are 'equivalent' when, and only when, they produce the same effect on the linear and on the angular momentum of any material system to which they may be applied: *i.e.* when they produce the same rate of change of momentum in any assigned direction, and the same rate of change of moment of momentum about any assigned axis." He believes that on examination the objections arising from the supposed difficulty and abstruseness of this mode of treatment, "will disappear, and that *on the whole* the method will be found to be really much simpler than that at present in vogue. The main difficulty is at the outset."

A brief but interesting discussion followed, enlivened as it was by a friendly passage of arms over the term *force of inertia.*

R. T.

THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS

PART V.

1. *Influence of Strength of Acid*

IN the second part of this communication in NATURE, vol. xxv. p. 461, when treating of the charging of the cell, we pointed out that in the electrolysis of dilute sulphuric acid between lead electrodes, two totally different reactions might be obtained. The positive metal becomes thinly coated with lead sulphate when the current employed is of small density, but with lead peroxide when the density of the current is of greater magnitude. This latter action is, of course, what takes place in the ordinary formation of a Planté battery. The chemical change, therefore, which goes on at the positive electrode is to a certain extent dependent upon the strength of the current. It appeared also of both theoretical and practical interest to determine whether the chemical change was also influenced by the strength of the acid employed. Our experiments consisted in passing a current of uniform strength, about 1 ampere, between electrodes of lead, 12 square inches in size, in varying strengths of sulphuric acid, and estimating in each case the amount of oxygen fixed by the positive electrode. We determined this for successive five minutes of time, and as such actions are not always very uniform, we made in each instance more than one experiment. The results are given in the following table:—

Strength of acid.	Expt.	Percentage of oxygen fixed.				
		First 5 mins.	Second 5 mins.	Third 5 mins.	Fourth 5 mins.	Total.
1 to 5	I.	38·1	28·6	28·6	33·3	128·6
	II.	39·5	30·2	25·6	30·2	125·5
1 to 10	I.	43·4	38·7	29·2	34	145·3
	II.	44·1	39·3	29·3	34·9	147·6
1 to 50	I.	48·3	39·6	35·3	22·4	145·6
	II.	46·2	43·9	23	30	143·1
	III.	54	40	35·3	35·5	165
1 to 100	I.	42	38·3	33·9	29·5	143·7
	II.	42·4	40	37·8	35·5	155·7
	III.	51·1	44·2	34·9	34·9	165·1
1 to 500	I.	46·6	32·6	27	27	132·6
	II.	46·4	27	27	18	118·4
1 to 1000	I.	90·6	81·1	76·4	57·5	305·6
	II.	90·8	77	72·3	63·1	303·2

It appears from this that the strong sulphuric acid (1 to 5) is not quite so favourable to the action as the more dilute (1 to 10), but that between this latter proportion and 1 to 500 there is no great difference in the amount of oxygen fixed, and therefore of corrosion of the plate. The appearance of the plate in every instance indicated the formation of only lead peroxide. With sulphuric acid diluted with 1000 parts of water, the amount of oxygen fixed, and therefore of corrosion, was at least doubled, while the chemical action was very different. On parts of the electrode, streaks of a mixture apparently of the yellow and puce-coloured oxides were seen. On other parts a white substance formed and was easily detached, falling in clouds into the liquid. Where this latter action took place, the plate was visibly the most corroded. This white substance gave on analysis SO_4 equivalent to 73·6 per cent. of lead sulphate, suggesting the idea that it was a basic sulphate of the composition $2PbSO_4,PbO$, which would require 73·1 per cent. As the peroxidation of the lead is required, and the corrosion of the plate is to be avoided as much as possible, it is evident that this extremely dilute acid must be avoided. It has already been shown that if the sulphuric acid is entirely removed from solution, as sometimes happens in an accumulator, the lead is simply converted into the hydrated protoxide, and therefore corroded without any good effect.

2. *Function of Hydrogen.*—In the formation of a secondary cell, after the complete reduction of oxide or sulphate to metallic lead, bubbles of hydrogen gas are seen to escape from the lead plate. It has been assumed that a portion of this is occluded by the lead, or in some other way enters into association with it, and it has been

supposed that this hydrogen compound may play an important part in the subsequent production of electromotive force. It therefore appeared desirable to obtain experimental evidence as to whether hydrogen is so absorbed. The process we adopted for this purpose was founded upon the observation of Graham that hydrogen associated with palladium reduced ferri- to ferro-cyanide of potassium, and that generally in the occluded condition the element was more active chemically. We had previously ascertained that hydrogen associated with other elements, as platinum, copper, and carbon, was capable of reducing potassium chlorate to chloride. This method seemed to give trustworthy results, and therefore we applied it in this instance. As the result of several trials, however, we found that the amount of hydrogen associated with the reduced lead was almost inappreciable. Small as this quantity is, however, it is by no means impossible that it may be the cause of the exceedingly high electromotive force observed for the first few moments, on joining up a completely formed cell immediately after its removal from the circuit of the charging current. This, however, may be due, as Planté imagined, to the gaseous hydrogen itself. The principal if not the only function of the hydrogen of the water or sulphuric acid is therefore that of reducing the lead compounds.

By a totally different process Prof. Frankland has very recently come to the same conclusion as ourselves in regard to the exceedingly small amount of occluded hydrogen.

3. *Evolution of Oxygen from the Peroxide Plate.*—Planté noticed a small escape of gas from the negative plate of his cell immediately after its removal from the influence of the charging current. This he attributed to a decomposition of water by means of local circuits between the peroxide and the subjacent lead plate in contact with it.

The explanation we gave in our first paper (NATURE, vol. xxv. p. 221) of the local action which goes on at the negative plate does not account for the escape of any gas—either oxygen or hydrogen. We therefore thought it of interest to ascertain the nature, and if possible the origin, of the gas noticed by Planté.

We found that the escape of gas from a Planté negative plate was very slight, and soon ceased; but we observed that it became much more pronounced when the temperature of the electrolytic liquid was raised. In order to get a sufficient quantity of the gas for examination, we prepared a negative plate according to the procedure of Faure, and then heated it in dilute acid, with an arrangement for collecting the gas as it was evolved. The amount of gas was still very small in comparison with that of the peroxide, but a sufficient quantity was collected to enable us to ascertain that it was oxygen. We next heated some of the electrolytic peroxide apart from the lead plate, and again noticed a similar evolution of gas, which was also found to be oxygen. This shows, therefore, that it was not a result of local action.

The gas has generally some odour of ozone, and, on testing the dilute acid between the plates of a Planté cell, we always found traces of something that bleached permanganate of potassium, and which might be either ozone or peroxide of hydrogen.

The origin of the gas noticed by Planté may be easily attributed to the oxygen which always passes off in quantity from the peroxide plate during the process of "formation." It is only necessary to suppose that some of this becomes condensed on the peroxide, and is gradually eliminated from it when the surrounding conditions are changed. But the matter is capable of another explanation. If peroxide of hydrogen be really formed in the liquid, it will exert its well-known influence on higher oxides, namely, that of reducing them and itself at the same time. As a matter of fact, if peroxide of lead is dropped into peroxide of hydrogen oxygen is evolved.

4. *Temperature and Local Action.*—Planté has recently pointed out that an elevation of temperature facilitates the formation of his secondary cell (*Comptes Rendus*, August, 1882). The character of the chemical changes which took place at the negative plate led us to think it exceedingly probable that this increase in the rate of formation arose from an augmentation in the amount of local action. Experiment showed such to be the case. Pairs of similar negative plates on Planté's model were allowed to remain in repose at 11° C. and 50° C. respectively, and the formation of the white sulphate was visibly more rapid at the higher than at the lower temperature. The same is also true with negative plates prepared by Faure's process. Thus we found that two similar plates kept in repose for an hour, the one at 11° C. and the other at 50° C., formed by local action 2·6 and 7·4 per cent. of lead sulphate respectively. On two other plates the proportions were 7·6 and 9·5 per cent. respectively. These observations of course by no means exclude the idea that an increase of temperature may facilitate the other chemical changes that take place in the formation of a lead and lead-oxide cell.

J. H. GLADSTONE
ALFRED TRIBE

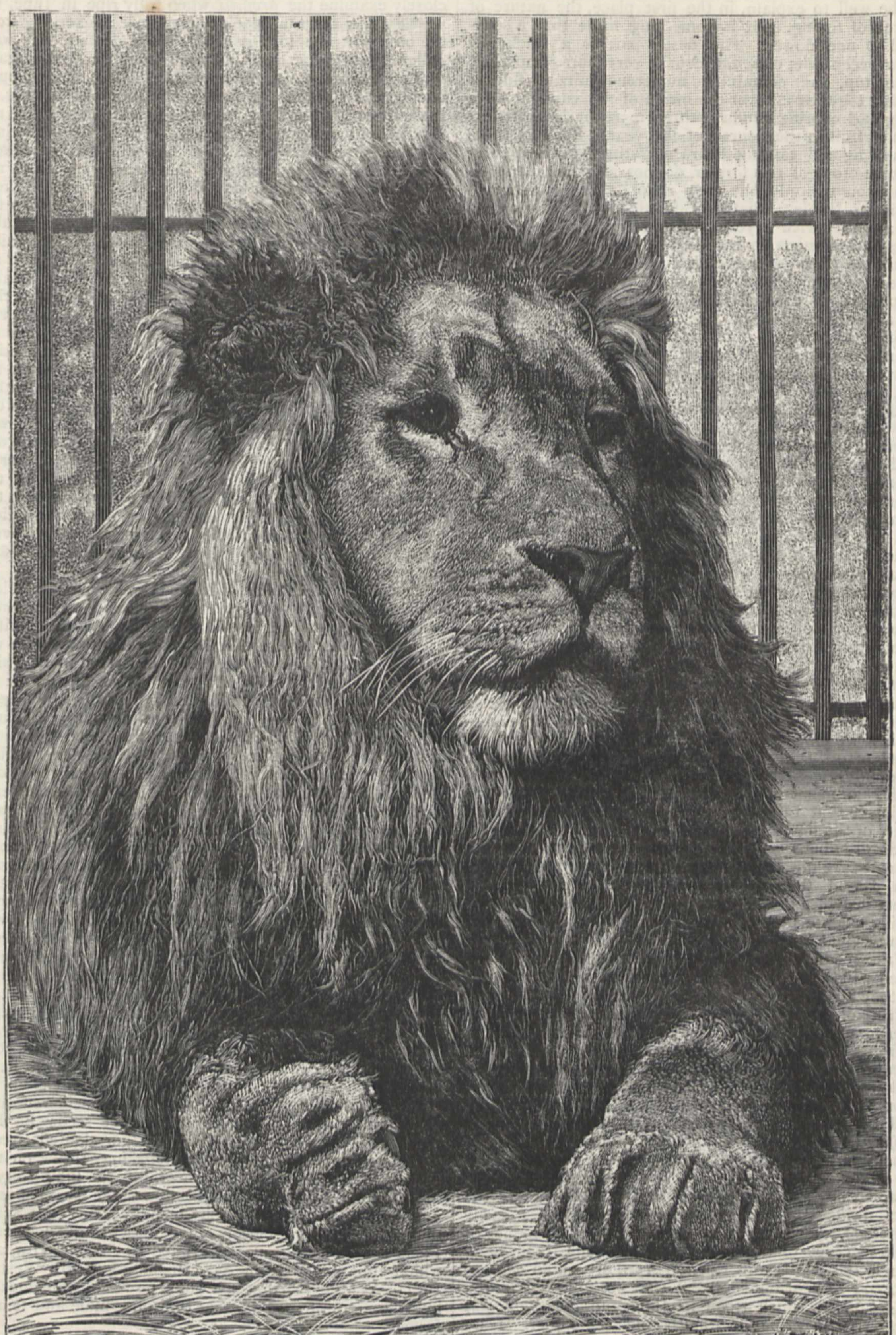
THE LION AT REST

THE illustration which we give on next page, from *La Nature*, is after a photograph of one of the lions in the Zoological Gardens, London. This photograph may be regarded as one of the numerous triumphs of instantaneous photography, valuable both to art and science. The original was rephotographed in Paris directly on wood, by means of a special collodion, at present much used. This has assured a perfectly faithful reproduction of the original, exhibiting all the characteristic details of the lion at rest. The illustration tells its own story.

ON THE RELATIONS OF THE FIG AND THE CAPRIFIG[1]

THE relations of the fig and the caprifig, or the cultivated varieties of fig and the wild form of the Mediterranean region, have been variously explained by different writers, including those recent ones whose works are cited below. Intimately connected with this question is the process of caprification, so often and so circumstantially described by ancient and modern authors, amongst the later of whom we may mention Gasparrini. Graf Solms-Laubach's essay is an elaborate work of upwards of one hundred quarto pages, embodying the results of much research. Not the least interesting part is that treating of caprification, or perhaps we might say the manner in which fertilisation is effected. The author regards the cultivated edible varieties of fig as constituting one race, and the wild caprifig as another race of one and the same species; and the former as having developed from the latter under the influences of cultivation. Gasparrini, on the contrary, described them as distinct genera. Dr. Fritz Müller takes an altogether different view. He says it appears to him far more likely that the fig and caprifig represent, as Linnæus supposed, different forms, the male and the female, belonging together, and not proceeding the one from the other, but which developed side by side, before any cultivation, through natural selection. An examination of the facts adduced by Solms-Laubach himself seems to point to the correctness of Müller's view. But we will set them forth as briefly as possible, leaving the reader to judge for himself. The responsibility of their accuracy rests with the author whom we are quoting. It

[1] "Die Herkunft, Domestication und Verbreitung des gewöhnlichen Feigenbaums (*Ficus Carica*, L.)." Von Grafen zu Solms-Laubach. (Göttingen, 1882.)—"Caprificus und Feigenbaum." Von Fritz Müller. *Kosmos*, xi. p. 306.—"Sulla Caprificazione, &c." G. Arcangeli. Processi Verbali della Società Toscana di Scienze Naturali, November, 1882.


E.A.TILLY. S.C.

may be well to explain, in the first place, the nature of the fruit of the fig, as it is something more than a seed-vessel of one flower. The fleshy part is a thickened hollow receptacle, closed, except a very narrow aperture at the top, and containing numerous minute flowers crowded together all over the inside of the cavity. Both the fig and caprifig produce three more or less distinct crops of fruit in the course of the year. Each of these crops of fig and caprifig bears a distinctive name; but the three crops of the former do not all reach maturity. In this country only one crop ripens. The varieties of the fig in Naples, whether cultivated or wild, produce fruit at least twice a year, and different varieties exhibit diverse phenomena in the degree of development and maturation of the several crops. In the fig the tissue of the receptacle or inflorescence is fleshy, and the perianth and pedicels of the individual flowers it contains thicken and abound in a sugary juice; whilst the fruit of the caprifig remains hard and milky up to maturity, or only imperfectly softens just at last without any secretion of sugar, and then shrivels and dries up. As long ago as 1770, Colin Milne[1] recorded the fact that the varieties of fig cultivated in England contained only female flowers; and Graf Solms found that male flowers were almost invariably altogether wanting in the varieties cultivated in Naples, and in the very rare exceptional instances in which they were present they were imperfectly developed and abnormal, the anthers being commonly replaced by leafy organs. On the other hand the inflorescence of the caprifig, as observed in Naples, usually contained both male and female flowers, the latter covering the greater part of the surface of the cavity, and the former restricted to a zone, variable in breadth, in the neighbourhood of the apical aperture. It is, moreover, noteworthy that the inflorescence exhibits proterogynous dichogamy in a marked degree. At the time when the female flowers are in a receptive condition the male flowers are still in a very early stage of development. The significance of this will perhaps be better understood after reading the description of caprification—that is if we may assume with Müller that this is really a process of fertilisation, in which there is a mutual adaptation of the inflorescences of the fig and caprifig and the insect which is an agent in procuring fertilisation. Before proceeding to that description, it should be mentioned that a variety of the fig exists in Brittany in which normal male flowers are abundantly produced. Yet, as in the caprifig, the males are not developed until long after the females have passed the receptive stage. The position this variety occupies in relation to other varieties and to the caprifig has not been ascertained. It may be a reversion to an original monœcious condition.

With regard to caprification, it was known to the ancients that an insect inhabits the fruit of the caprifig, and they also discovered that the visits of this insect to the fruit of the fig exercised some beneficial influence, either in accelerating ripening or in hindering the fall of the fruit before it was ripe. Consequently, branches of the caprifig were hung on the fig-trees at a certain season to insure these visits, and effect what was termed caprification. The insect that operates in this manner is a small hymenopter (*Blastophaga grossorum*, Grav syn. *Cynips psenes*, Linn.), the complete annual cycle of development of which takes place within the three crops of fruit of the caprifig, whilst only one generation visits the fig, and that, as will be seen, to no advantage to the insect itself. In order to render what follows easily understood, we will give the present Neapolitan names of the three crops of the caprifig. The fruits that hang through the winter and ripen in April are called *mamme* (*cratitires* of the ancients). These are followed by the *profichi* (*orni*), which ripen in June, and the *mammoni* (*fornites*), which ripen in August and September. If we closely examine the *profichi* when fully ripe in June, we see here and there a black-winged insect emerging from the orifice at the top, its hairy body dusted over with pollen grains that have adhered to it in its passage through the zone of male flowers. And if we cut open one of these fruits, we find a considerable number of these insects, all striving to find the way out. These are females and associated with them are some helpless wingless males, and very often a number of a slender ichneumon as well. The female of this generation visits not only the *mammoni*, but also the fruits of the fig, if there are any at hand, in order to deposit her eggs. Now the remarkable fact in connection with this is that she is able to do so effectually in the *mammoni*, but not in the edible fig, though she succeeds in penetrating the fruit far enough to convey pollen to the female flowers, perishing in the act. Furthermore the generation of the insect that develops in the *mammoni* deposits eggs in the *mamme*, and the generation proceeding therefrom finds an asylum for its progeny in the *profichi*. Respecting the reproduction of the *Blastophaga*, Graf Solms claims to have made the important discovery that the eggs must be deposited within the integuments of the ovule itself; otherwise they do not develop. The fertility of the insect is astonishing, a very few of them being able to pierce the numerous female flowers of a fruit of the caprifig. For this purpose the ovipositor is thrust between the branches of the stigma, down the pollen channel of the style into the ovary, and into the solitary ovule itself. This act causes a gall-formation, whilst it does not prevent the development of the ovule into an imperfect seed, which shelters and nourishes the larva that escapes from the egg.

The foregoing condensed extracts are perhaps sufficient to give an idea of the only way in which the female flowers of the fig are fertilised by the male flowers of the caprifig. It seems to be almost certain that seedling figs are unknown in countries where the caprifig does not exist. Where it is found apparently wild it is rather as the remains of cultivation than as plants sprung up from seeds. With regard to the origin of some of the cultivated varieties purporting to have been raised from seeds produced without the intervention of the caprifig, they offer a field for further research and experiment. Possibly they owe their origin to what has been called parthenogenesis, and more recently adventitious embryo-formation. Passing over many other interesting particulars in Graf Solm's essay, we come to one which Dr. Müller regards as strongly in favour of his view. It is this, the seedling offspring of the fig, fertilised by the caprifig, are said to consist of varieties of the fig and the caprifig, pure and simple, without any forms intermediate beween the two parents. On the other hand it is stated that a perfect seed is now and then found in the *profichi*. Prof. Arcangeli, in a later memorandum on the subject, states that he is unable to pronounce judgment in favour of one or the other of these views, and confines himself to recording the following observations on wild and cultivated forms. The *Fico verdino* and the *Fico piombinese* are commonly cultivated varieties in Pisa, yet he had never found a single perfect seed in their fruit, whereas in the fruit of the *Fico biancolino*, which is considered as a wild form, among numerous imperfect seeds he had found some perfect ones, which germinated freely. Whatever light future investigations may throw on this subject, the foregoing facts concerning the life-history of the *Blastophaga* and the fertilisation of the fig are of great interest. In conclusion it may be added that Graf Solms found the same or a closely allied insect in the species of Ficus that are most closely related to *Ficus Carica*, and which inhabit Western Asia, including North-Western India. As Müller suggests, it would be worth while looking into the matter to see whether they offer male and female forms.

W. BOTTING HEMSLEY

[1] "A Botanical Dictionary," in the article on "Caprification."

NOTES

THE Queen has been pleased to confer the honour of Knighthood upon Dr. C. W. Siemens, F.R.S.

M. WOLF has been nominated Member of the Academy of Sciences by 32 votes against 21 given to M. Bouquet de la Grye. At Monday's meeting M. Jordan pronounced the *éloge* of Prof. Henry Smith, and M. Bertrand gave an explanation on the double prize, to which we referred last week. He stated that the Commission was aware of the existence of the paper of Prof. Henry Smith, and that it was to oblige Prof. Smith to publish his valuable secret that the prize-subject was selected.

UP to the present date, we understand, there have been received in answer to the official letter of inquiry to the Members of the British Association, as to whether they intended to go to Montreal or not, replies in the affirmative from 340. Among these are a good many who may be said to be really representative of English science, but as might be expected the younger men are present in a larger proportion than the older.

THE Annual Meeting of the Iron and Steel Institute will take place at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Wednesday, May 9th, and two following days. On Wednesday, May 9, the Bessemer Gold Medals for 1883 will be presented to Mr. George J. Snelus and Mr. Sidney Gilchrist Thomas. During the meeting the following papers will be read :—On the Value of Successive Additions to the Temperature of the Air used in Smelting Iron, by Mr. I. Lowthian Bell, D.L., F.R.S., Middlesborough; Comparison of the Working of a Blast Furnace with Blast varying in Temperature from 990° F. to 1414° F., by Mr. William Hawdon, Middlesborough; on American Anthracite Blast Furnace Practice, by Mr. Thomas Hartman, Philadelphia; on the Northampton Iron Ore District, by Mr. W. H. Butlin, Northampton; on Steel Castings for Marine Purposes, by Mr. William Parker, of Lloyds; on the Separation and Utilisation of Tar, &c., from Gas in Siemens' Gas Producers, by Mr. W. S. Sutherland, Birmingham; on Improvements in Railway and Tramway Plant, by M. Albert Riche, London; on the Estimation of Minute Quantities of Carbon by a New Colour Method, by Mr. J. E. Stead, Middlesborough; on the Tin-plate Manufacture, by Mr. Ernest Trubshaw, Llanelly, South Wales; on the Coal-washing Machinery used at Bochum, in Westphalia, by Mr. Fritz Baare, Bochum.

WE regret to announce that Dr. William Farr, C.B., formerly Superintendent of the Statistical Department of the Registrar-General's Office, died on Saturday night. He was born in 1807, at Kenley, in Shropshire, was educated at Shrewsbury, and afterwards proceeded to the Universities of Paris and London. After discharging the duties of house-surgeon of the Infirmary at Shrewsbury for a short time, he continued the practice and teaching of medicine in London, editing the *Medical Annual* and the *British Annals of Medicine*. In 1838 he was appointed Compiler of Abstracts in the Registrar-General's Office, where he organised the statistical department, of which he was made superintendent. In this capacity he assisted in taking the census in 1851, 1861, and 1871. He was author of a large number of articles, contributions to medical journals and papers relating to statistics of health and kindred subjects. He wrote many official reports on Public Health, on the Cholera Epidemic of 1849, and on the Census; and he constructed the English Life Tables, with values of annuities. Dr. Farr was Corresponding Member of the French Institute. It may be remembered that a few years ago considerable disappointment was felt that, when a vacancy occurred in the office of Registrar-General, Dr. Farr was not appointed to the post, with the work of which he had so long been credited.

MAJOR-GENERAL H. G. D. SCOTT, C.B., F.R.S., late Royal Engineers, died on Monday morning at his residence, Silverdale, Sydenham, aged 61. He was educated at the Royal Military Academy, Woolwich, and entered the Royal Engineers in 1840. He acted as instructor in surveying and practical astronomy at Chatham, and also as examiner of military topography for the Military Education Department at the War Office. He retired from the army in 1871 as major-general, and became Director of Buildings at South Kensington, acting as architect to the Royal Albert Hall and Science Schools. He was secretary to the Royal Commissioners of the 1851 Exhibition. He has just finished superintending the construction of the Great International Fisheries Exhibition.

PROF. FRANCIS MARCET, who died a few days ago in London at an advanced age, though English by birth, was a Swiss by adoption and family connection, and spent the greater part of his long life in Geneva. Marcet's achievements in science were numerous and noteworthy, and procured for him the Fellowship of the Royal Society. Some of his discoveries, especially those concerning the boiling point of water, the determination, by freezing, of the specific heat of solids, and, above all, his observations at Pregny on the increase of temperature of artesian wells, are recognised as important. Several of these observations were made in collaboration with his friend, Auguste de la Rive. In conjunction with De Candolle he made a series of researches in vegetable physiology and the action of poison on plants, and his "Manuel de Physique élémentaire," albeit now out of date, ranked forty years ago as the best scientific text-book of the period.

THE French Government are steadily continuing their excellent work of deep-sea investigation. Their vessel, the *Talisman*, is now being equipped and fitted out with the most improved machinery and apparatus, and will leave on June 15 for Morocco, the Canaries, Cape Verd Islands, Azores, and the Sea of Sargasso. Our last expedition of this kind, in the *Challenger*, although highly successful considering the great extent of area traversed by it, might be considered in one respect tentative, and ought to have led to further results. Our own seas have never been sufficiently investigated, while the Americans, Norwegians, Germans, French, and Italians have, especially of late years, been indefatigable in thoroughly exploring their parts of the North Atlantic and Mediterranean.

FROM Monday's debate it is evident that the new Patent Bill will not satisfy everybody, which was just what might be expected. It is certainly a great improvement on the existing law. The provision with regard to the Patent Museum seems to us a step in the right direction. The Bill provides that the control and management of the existing Patent Museum and its contents shall be transferred to and vested in the Department of Science and Art, subject to such directions as Her Majesty in Council may see fit to give. The Department of Science and Art, moreover, may at any time require a patentee to furnish a a model of his invention for deposit in the Patent Museum on payment to the patentee of the cost of the manufacture of the model. Another commendable provision is that the Comptroller shall cause to be issued periodically an illustrated journal of patented inventions, as well as reports of patent cases decided by courts of law, and any other information that the Comptroller may deem generally useful or important.

THE Birmingham Natural History and Microscopical Society has established a "Sociological Section," for the study of Mr. Herbert Spencer's system of philosophy. The section originated in a wish to unite, for the purpose of mutual help, those who were already students of Mr. Herbert Spencer's system, but were unknown to each other, and to introduce to the synthetic philosophy those already engaged in some special biological study, but as yet unfamiliar with the principles common to all departments of natural history. Mr. Herbert Spencer, who is already an honorary vice-president of the Society, has been communicated with, and has expressed his cordial approval of the course of work proposed to be done by the section, adding some valuable suggestions. It is intended to go through the whole of his works, discussing special points as they arise, and where practicable giving illustrations. The president of the section (Mr. W. R. Hughes, F.L.S.) will open the first meeting with a brief address.

SEVERAL contributions to the theory of the microphone have lately appeared. Mr. Shelford Bidwell has communicated to the Royal Society a series of determinations of the changes of resistance of a microphonic contact under different pressures; and comes to the conclusion that the mere fact that a current causes delicately adjusted metal contacts to adhere to each other seems sufficient to account for the superior efficiency of carbon. Mr. Bidwell also thinks that the heat generated at the contact by the current plays an important part, for in carbon this reduces the resistance, whilst in metals it increases it. Mr. Bidwell's experiments on metals were, however, confined to the metal bismuth, which, being both the most fusible and the worst conductor, is the very one which ought to have been avoided. No conclusion of any value as to the metals in general can be drawn from experiments on bismuth alone. Mr. Oliver Heaviside has also experimented on the microphone, and finds the apparent resistance of a contact to vary inversely as the square root of the current. Arguing from these observations he concludes that it is no use to arrange a number of microphones either in series or in parallel. This result is, however, contradicted by experience, for a transmitter such as the Hunnings, with many contacts in parallel, is much more powerful than the single-contact Blake transmitter. Moreover the results attained in Paris lately by M. Moser using a "battery" of microphones arranged partly in series, partly in parallel, disposes of this conclusion of Mr. Heaviside's. It may be remarked that the suggestion to use a battery of microphones was made in 1881 by Prof. Silvanus Thompson. Messrs. Munro and Warwick have lately produced some successful telephonic or microphonic transmitters with metal contacts. These experimenters regard the action of the microphone as due to the existence of a silent discharge of electricity through the thin air stratum at the contact. This view is perhaps sustained by a remarkable observation due to Mr. Stroh, that when a current is passed through a carbon microphone of a peculiar type there is a very minute repulsion observable between the two pieces of carbon, the actual movement being through a distance of ·0005 of a millimetre!

Litera scripta manet is a phrase which is literally true of China. It is generally mentioned in popular books on that country that the respect for paper on which any words are written is so great that scavengers are specially employed to collect it in the streets and preserve it. Whatever doubt existed on this score must now be set at rest, for in a recent issue of the *Peking Gazette* we find a memorial to the throne from the Police Censor of the central division of the capital, reporting that there are in that city over eighty establishments for the remanufacture of waste paper. Paper with characters on it, the memorialist complains, used to be mixed up with the waste paper and defiled by being applied to such base uses. The memorialist and his colleagues published proclamations embodying the sacred edict of the great Emperor Kang-hi, that in heaven and earth there is nothing more precious than written characters. Shopkeepers were forbidden to traffic in printed or written paper, and the manufacturers were ordered to pick out all such paper from among the waste paper purchased by them, and send it to the offices, where a certain amount per pound would be paid for it. Two temples were selected where this paper could be properly burned periodically. The police magistrates on inquiry find that now the manufacturers have some idea of the reverence due to written characters; but some permanent means of supporting the expenses of the purchase and sacred process of destruction should be established, as at present the memorialist has to pay them out of his own pocket. He further suggests that the sale of the house and furniture of a certain escaped criminal, though they will not fetch much, will be sufficient, if put out at interest, to meet these expenses; and he further requests that the sale of written paper to manufacturers be forbidden. The Imperial rescript on this memorial has not come to our notice; but in all probability the escaped criminal's house and furniture are now employed in preventing the defilement of the "*fliegende Blätter*" of Peking.

ACCORDING to the *China Mail* telegraphs in China are likely to receive a most important extension in the shape of a line from Canton to Shanghai. Should this line be constructed, the southern port will then be in direct connection with Tientsin. Lead ore, according to the same authority, has been discovered in Kwantung, the province in which Canton is situated; and it is proposed to work mines of this metal. These movements are stated to be purely Chinese, "and as signs of progress they are worthy of the most attentive consideration."

FROM Mr. J. F. Duthie's "Report on the Progress and Condition of the Government Botanical Gardens at Saharunpur and Mussoorie for the Year ending March 31, 1882," we learn that many additions have been made to the Gardens, of interesting and valuable economic plants, among them the *Cassia marilandica*, L., or North American senna plant, the wax palm of the Andes (*Ceroxylon andicola*, Humb.), upon the trunks of which large quantities of wax are formed and is easily removed by scraping, *Ferula tingitana*, L., the ammoniacum plant of Morocco, *Fraxinus ornus*, L., the manna ash of the Mediterranean region, *Guaiacum officinale*, L., the lignum vitæ of commerce, *Quassia amara*, L., one of the bitterwood trees from the West Indies, *Rheum palmatum*, L., var. *tanguticum*, a native of North-West China, one of the species which yields medicinal rhubarb. Besides these, many new fruits, vegetables, and fodder plants have been under cultivation. Mr. Duthie reports a very important item of cultivation, that of drug-yielding plants for the supply of drugs for the use of the medical department. Extract of henbane and extract of taraxacum have both been made, and Mr. Duthie has prepared a list of other drugs which he proposes to cultivate either in the hills or at Saharunpur. Amongst these may be mentioned aconite, aloes, buchu, calumba root, colchicum, digitalis, gentian, jalap, liquorice, scammony, colocynth, and others. It seems that the cost of maintaining the Saharunpur Gardens much exceeds the income derived from them; but being kept up mainly for scientific purposes they are not expected to prove directly remunerative. It further appears that sanction has lately been given to the closing of the Gardens at Mussoorie and Chajri, which it has been found impossible to work successfully. A new Hill Garden, however, is to be opened at a more eligible site.

THE valuable geological and palæontological collections from Spitzbergen made by Dr. A. Nathorst and Baron De Geer last summer will be distributed between the National Museum and the Geological Museum at Stockholm, while the duplicate specimens will be presented to the museums in Upsala, Lund, and Gothenburg.

THE Second Part of vol. i. of Thomson and Tait's "Natural Philosophy," second edition, is announced for immediate publication, edited for the most part by Prof. F. Darwin. The remaining volume, originally planned, will not be published.

PROF. O'REILLY writes from the Royal College of Science for Ireland, Dublin, that there was visible there, on the night of the 16th, between 10 and 11 o'clock p.m., an aurora appearing as a glow, but without any beams when observed. The wind on the 17th was from the south, but the temperature was still relatively low.

THE opening of the proposed International Horticultural Exhibition and Botanical Congress at St. Petersburg has been postponed to May 5, 1884.

THE Council of the Popular Observatory of the Trocadéro has decided to open a series of Sunday lectures, illustrated by experiments, during the whole of the summer season. The Thursday lectures will be devoted to astronomical topics and delivered in the evening, and will be followed by demonstrations on the sky itself, weather permitting.

DR. DOBERCK, whose appointment to Hong Kong we noted last week, has been attached to Markree and not to Dunsink Observatory.

THE additions to the Zoological Society's Gardens during the past week include a Rude Fox (*Canis rudis*) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; an Arabian Gazelle (*Gazella arabica* ♀) from Arabia, presented by Mr. J. Sewell; three Weasels (*Mustela vulgaris*), British, presented by Mr. George Lang; a Wood Owl (*Syrnium aluco*), British, presented by Capt. E. Hall; a Lanner Falcon (*Falco lanarius*) from Eastern Europe, presented by Major J. H. Hussey; a Common Raven (*Corvus corax*), British, presented by the Earl of Eldon; five Mississippi Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. Thos. Baring; two Common Snakes (*Tropidonotus natrix*), British, presented by Lord Londesborough, F.Z.S.; two White-fronted Capuchins (*Cebus albifrons* ♂ ♀) from South America, presented by Mr. H. Smith; a Palmated Newt (*Triton palmipes*), British, presented by Mr. J. E. Kelsall; two Amherst's Pheasants (*Thaumalea amherstiæ* ♂ ♀) from Szechuen, China, deposited; three Lions (*Felis leo* ♂ ♀ ♀) from South Africa, two Reeves's Pheasants (*Phasianus reevesi* ♂ ♀) from China, a Great Black Cockatoo (*Microglossa aterrima*) from New Guinea, a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, a Common Otter (*Lutra vulgaris*), British, purchased.

OUR ASTRONOMICAL COLUMN

D'ARREST'S COMET.—We last week referred to the discovery of D'Arrest's comet at the Observatory of Strasburg on the 3rd inst., upon the strength of a telegram received at Lord Crawford's observatory from Prof. Krueger, to the following effect:—"Dr. Hartwig discovered on April 3·610 G.M.T. D'Arrest's periodical comet in right ascension 13h. 55m. 24s., declination +8° 16′. Daily motion −44s. in R.A., and + 9′ in declination." This telegram was published in the Dun Echt Circular, No. 76, but in No. 77 issued five days later we read, "Prof. Krueger telegraphs that the object observed by Dr. Hartwig was not D'Arrest's comet but a new nebula." The "daily motion" assigned to the object in the first telegram, notwithstanding its precise accordance in amount and direction with that which the comet would have had in that position, was therefore an illusion. The calculated place of the comet for April 3·610 G.M.T. is in R.A. 13h. 55m. 11s., Decl. +8° 23′·6. During the next period of absence of moonlight for which an approximate ephemeris was given in this column last week, the theoretical intensity of light will be nearly one-third greater than on April 3.

THE GREAT COMET OF 1882.—Prof. Riccò sends us the following observation of this comet made with the 10-inch refractor at Palermo:—

	M.T.		App R.A.		App. Decl.
	h. m. s.		h. m. s.		° ′ ″
April 6 at	8 21 29	...	5 58 5·93	...	−9 4 49·2

He states that the comet was a very faint nebulosity with an elongated nucleus containing two or more points. At this time the comet was distant from the earth 3·87, and from the sun 3·75.

In *Bulletino della Società di Scienze Naturali di Palermo* for February 8 we find some remarks by Prof. Riccò on the circumstances attending the passage of the comet through perihelion. On studying the appearance of the sun from twelve to fifteen hours afterwards, he found the prominences were by no means unusual either as regards number or dimensions; there were nine with a greater altitude than 30″, and about as many smaller ones; the highest was one of 85″ on the west-north-west limb, opposite to the part of the disk traversed by the comet, in which no prominences were visible. The comparison of observations made before and after perihelion passage, shows that no very sensible effect was produced upon the motion of the comet in its course through the coronal atmosphere, and Prof Riccò concludes, on the other hand, that his own observations, made a few hours subsequently, "possono servire a constatare che reciprocamente la cometa non disturbò per nulla il corso degli ordinari fenomeni dell' attività solare."

THE BINARY STAR *p* ERIDANI.—In a communication to the Royal Society of New South Wales in June, 1880, Mr. Russell, the director of the Observatory at Sydney, suggested, from the measures made since 1856, including his own up to 1880, that this object might not be a binary star at all, but merely afforded an instance of one star passing before another by reason of its proper motion. This opinion is repeated in the volume of double-star results obtained at Sydney, published last year. "In fact," observes Mr. Russell, "a straight line accords better with all the observations made subsequent to Herschel's than any ellipse, and it would appear that the changes are due simply to proper motion; of this I think there cannot be any doubt. . . ." The question has just been very fully and carefully considered by Mr. Downing, of the Royal Observatory, Greenwich, who arrives at an opposite conclusion to that of Mr. Russell, and considers "there is not sufficient evidence to justify us in asserting that *p* Eridani is other than a binary star." We entirely agree with Mr. Downing in his opinion. If we only compare the measures made by Jacob in 1845-46, with those of Russell and Tebbutt, 1878-80, we get the following expressions:—

$$d\,.\sin p = -\,4''\!\cdot\!361 - [8\cdot3894]\,(t - 1850\cdot0)$$
$$d\,.\cos p = +\,0''\!\cdot\!122 - [9\cdot1017]\,(t - 1850\cdot0)$$

showing differences from Herschel's mean measures, epoch 1834·996, of −5°·1 in position, and + 0″·82 in distance, which are too large to be tolerated.

This star has been occasionally miscalled 6 Eridani, which would imply that it was one of Flamsteed's stars. Flamsteed, it is true, has a star which he calls 6 Eridani, and which is B.A.C. 926; the binary is B.A.C. 521. The letter *p* was attached to the star by Lacaille in the catalogue at the end of his *Cœlum Australe Stelliferum*. The number 6 is merely borrowed from Bode.

GEOGRAPHICAL NOTES

THE Geographical Society of Lisbon has awarded their gold medal for this year to Mr. Carl Bock, the distinguished eastern traveller, who has also been recently elected Corresponding Member of the Italian Anthropological Society.

THE third German Geographentag was held at Frankfort-on-the-Main on March 29 in the presence of 430 men of science. Prof. Rein (Marburg) delivered the inaugural address, and also opened the geographical exhibition, which comprised 1100 objects of interest. Amongst the most successful addresses we mention the following: Dr. Pechuël Loesche (Leipzig), on the mountain districts of the Congo River, in which he described minutely the mountain chains traversed by the Congo, according to the researches of Oscar Lenz and Güssfeldt. Prof. Ratzel (Munich), on the significance of Polar research with regard to geographical science; he proposed a resolution, "That the Geographentag recognises that the resumption of Polar research by the German Government is equally in the interest of geographical science and of the German nation." This resolution was adopted unanimously. Dr. Finger (Frankfort), on topography as an introduction to geography. Herr Mang (Baden Baden), on the method of the tellurium and lunarium. Dr. Breusing (Bremen), on the means for the determination of the position of localities at the time of great discoveries. Dr.

Buchner (Munich), on the tribe of Bantu negroes distributed through the whole of South-west Africa. Prof. Günther (Ansbach), on the latest investigations regarding the exact shape of the earth. Lieut. Wissmann, on his journey across Africa with Dr. Pogge. The oldest among the German African travellers now living, Dr. Rüppel, had come to Frankfort to greet Wissmann upon his return. The fourth Geographentag will be held at Munich.

FROM a paper by M. Smicroff on the climate of the Caucasus (published in the Caucasian *Izvestia*, and based on the researches of Dr. Wild on the temperatures in Russia), it is evident that although enjoying a warm climate, still the climate of the Caucasus, especially in the north, is quite continental. Thus, the average mean temperatures of the year are 5°·4 Cels. at Alexandropol, 8°·5 at Stavropol, 12°·6 at Tiflis, and 14°·3 to 14°·5 at Bakou, Lenkoran, Kutais, Poti, and Redut-kaleh; but the yearly range of the average diurnal temperatures is still (with the exception of the two last places) as much as 20 to 30 degrees, while in Central and Southern Russia it varies from 22 to 35 degrees. The highest temperatures observed on the Caucasus vary from 38°·5 at Tiflis, to 34°·4 at Poti; and the lowest from −25°·6 at Stavropol, to −17°·3 at Tiflis, and −6°·6 at Redut-kaleh. It is interesting to compare these temperatures with the +38°·8 and −62° observed at Yakutsk, and −63°·2 at Verkhoyansk. Altogether, it is only in Southern Transcaucasia that localities are found where the temperature does not fall below −10°, and the southern limit of the region beyond which temperatures lower than −20° are no longer found, runs from the Crimea to the Caucasus range, and along the northern slope of this last, towards Khiva, Tashkend, and Peking. The whole range of temperatures observed at Caucasian stations is 60°·4 at Stavropol, 55°·8 at Tiflis, 45°·9 at Bakou, 42°·1 at Poti, and 41°·6 at Redut-kaleh. Of course it is nothing in comparison with the range at Yakutsk, where the inhabitants must be accustomed to experience differences of temperature ranging a little more than 100° (from −62° to +38°·8). But still it is large enough, especially for the places situated on the plateaux. High-level meteorological stations are established at Goudaur (2156 metres above the sea-level) and Kvi am (2362 metres). Their average yearly temperatures respectively are 4°·1 (−8° in February and 14°·3 in August) and 1°·1 (−14° in January and 12°·3 in August).

THE last number of the *Izvestia* of the Russian Geographical Society contains an elaborate paper, by M. Malakhoff, on the anthropology of the Vyatka region; a description of inscriptions on rocks on the Yenisei, with drawings, by M. Schukin; a note on old Russian geography, by M. Arsenieff; an account on M. Balkashin's researches into the Kirghiz, being a most valuable addition to our very imperfect knowledge of them. The author comes to the conclusion that the Kirghiz are not a separate nation, but a federation of several nomad tribes who inhabited Southern Russia, the Go i, the neighbourhoods of Dalay-nor, the sources of the Black Irtish, and the shores of the Baikal, who were mingled together by Genghiz Khan and his successors. M. Grigorieff contributes a note in which he shows that Henriette Island, which was discovered by the *Jeannette*, is only the land which was sighted by Hedenström and Sannikoff from New Siberia in 1810, and that Bennett Island was seen by Sannikoff from the northern coast of New Siberia in 1811. There can be no doubt also that the land discovered by Sannikoff to the north-west of the northern extremity of the Kotelnyi Island exists in reality, but is more distant than Sannikoff supposed. This land, which was shown in dotted lines on older maps, but disappeared since Wrangell and Anjou's journeys, ought to be reintroduced on our maps. The same number contains a note on the map of Bokhara of the Greek Vatalsi, a necrological notice of M. Tchoupin, several notes, and a new edition of the complete bibliography of the Amoor, by M. Bousse. One of the notes contained new astronomical determinations and hypsometrical measurements on the Yu-tschou, by Dr. Fritsche; the Siao-Utai-shan proved to be only 9500 feet high, instead of the 11,452 feet given by Mellendorf.

ACCORDING to intelligence from Tashkend, dated March 31, received by the *Cronstadt Courier*, it is in contemplation to send two Russian Exploring Expeditions into Central Asia during the coming summer. The ostensible object of one is to survey part of the Pamir Steppe and fix certain points astronomically, with the object of connecting the Russian surveys with the English. The purpose of the other is to determine the astronomical position of places on the Oxus from the points of passage in its upper course down as far as Khiva, in fact the whole course of the river.

FROM M. De Lesseps's examination of the ground through which it is proposed to let the waters of the Mediterranean into the Tunisian and Algerian Chotts, he concludes that the scheme is perfectly practicable, and that there will be no difficulty as to boring and excavating. The size of the proposed inland sea will be fourteen times that of the Lake of Geneva.

THE SOARING OF BIRDS [1]

THE circling, soaring flight of birds on stiff, outspread wings appears to me a much more complex problem, and less easy of explanation, than that of motionless hovering (poising). At the same time it has certain definite and characteristic features, which must depend upon and connote certain definite aërial conditions, and which should therefore afford us so many hints toward the solution. The whole phenomenon has been very clearly described in NATURE (vol. xxiii. p. 10) by Mr. S. E. Peal, who appears to have had grand opportunities of observing it at Supakati in Assam. [The explanation which he gives is, however, insufficient, because he does not show how the bird in falling with the wind can acquire greater "impetus" *relative to the air* than it would if the air were still. But such greater "impetus" is necessary if the bird is to rise to a greater height than it would reach in still air.]

The most typical instance that I have observed was on January 8, 1882, near King's Lynn, in Norfolk. The whole country for many miles round is flat, broken only by trees, buildings, and sea walls or river embankments. The wind was strong from the south. The birds (large gulls) were drifting away northwards towards the Wash, circling as they drifted on stiff, outspread wings at a height of 200 or 300 feet, and apparently rising higher. The level nature of the land forbade the notion that the wind had received an upward throw from any fixed obstacle in its path (though I shall show below that there may be upward currents in the air without the presence of a fixed obstacle).

The circling appears to begin about 100 or 200 feet above the ground. A strong wind is a constant and (presumably) necessary condition. The bird descends with the wind, and then circles round to right or left, and rises against the wind to a greater height than it had before. Now if the whole mass of air were moving together horizontally with the same velocity throughout, this action would be wholly inexplicable, for the bird would feel no more wind in one direction than in another, and indeed would have no evidence of the existence of any wind at all except in glancing at objects on the earth. The fact that the earth is slipping away under the air in a certain direction does not affect the bird's relation to the air, and gives no reason why the bird should fall or rise at one phase of its circle more than at another. Still less does it furnish an explanation of the bird's progressive ascent. We may therefore infer as highly probable that the air in which the birds are circling does not move in a mass, but that there is some differential movement in it which makes a great difference to the bird, whether it rises or falls with or against the wind.

I think there are at least two types of differential movement in the upper air which admit of demonstration, and which should be tested in turn to see if either of them can give the meaning of the phenomenon of circling.

(1.) First, there is almost always *a greater velocity in the higher strata* of the air than in the lower. The lower strata are delayed by friction on the earth's surface, and the higher strata outrun them; just as the water of a brook is delayed by friction against its bank, but flows faster in mid-stream.

(2.) Secondly, where currents override or run past one another there is generally some *rolling* between them. This may be seen near the edge of any stream of water if the surface is smooth enough to exhibit the little swirls and whirlpools that are formed between the swifter and slower currents. In the air it may be seen on a grand scale on almost any windy day when there are separate floating clouds in the sky. Looking at right angles to the direction of the wind, each cloud is seen to have a

[1] Lord Rayleigh's valuable letter on this subject (NATURE, vol. xxvii. p. 534) gives me confidence in offering the following considerations, which I had prepared last February, and have submitted to two or three mathematical friends. I congratulate myself on finding my own views in such close agreement with Lord Rayleigh's.—H. A.

systematic movement within itself: the rearward skirts of the cloud are climbing up its sloping back, often with little rolling curls: the top of the cloud is rolling over like a breaker in the act of tumbling on the beach. Each cloud is in fact the scene of a travelling vortex in the air revolving round a more or less horizontal axis. And the persistency with which such a cloud will preserve its individual identity indicates the persistency of the vortex. In the comparatively lower regions of the air it may be difficult to demonstrate the presence of such vortices, but similar causes are present, and it cannot be doubted that similar effects are produced and that such vortices, possessing a proportionate degree of persistency, are generated in those regions of the air which are within the range of the habitual flight of circling birds.

Let us see what effect these conditions (1) and (2) separately would have upon the circling flight of a bird.

(1.) First, let us take horizontal currents increasing in velocity the higher they are above the earth; and suppose a bird at the highest point of one of its gyrations, when it has mounted against the wind and is wheeling to one side or the other, preparatory to the descent with the wind which is to give it sufficient velocity for another rise (but which could not enable it to rise to the same height as before if the air had no internal movement, for there would be no self renewing force to neutralise the ever-new force of gravity and the perpetual friction of the air). Let us regard the air at the level of the bird, at this turning-point, as *still*. Then, relative to this point, the lower strata of air have a horizontal velocity in the opposite direction to the wind (as perceived on earth); and the bird in falling apparently down the wind will really be meeting stronger and stronger adverse currents, and when it has reached the lowest point of the "circle," it will have a greater horizontal velocity relative to the air at that level than if the whole air through which it has fallen had been still. Therefore, in virtue of its greater horizontal velocity relative to the air (which is accompanied by increased air-resistance), the bird will be subject to a greater force upon its wing-surface, and will therefore be able to mount higher (*cæteris paribus*) than if it had fallen through still air. But (instead of "*cæteris paribus*") suppose the bird, as it rises, wheels gradually round and faces the wind. Then, in rising, it will enter successive strata of air having successively greater and greater velocity relative to itself (the bird) than if the air had no internal movement, and therefore the air-resistance, which is the lifting force, will ever be greater than that due to the height gained by the bird if in still air; and therefore the bird will be able to rise yet higher. But this manœuvre of wheeling to face the wind in rising will cost some time, during which gravity ceases not to act; it will also cost some friction and a slight loss of horizontal velocity, and the question is whether these losses are sufficient to destroy the advantage above described. This is a problem for the mathematicians to solve.

It seems difficult to imagine that within the narrow limits of the actual rise and fall of the bird at the different phases of its circle, there should be sufficient difference of velocity of upper and lower air-currents, to account for such a gain of elevation as Mr. Peal mentions (from 10 to 20 feet at each lap). We require, however, to know the vertical height of the bird's fall and subsequent rise. I have not seen any estimate of this, but, judging from Mr. Peal's diagram, the bird's fall appears no greater than its gain of elevation (10 or 20 feet).

Still it appears from the foregoing considerations that the bird will gain support by falling with the wind and rising against it, when the upper wind is stronger than the lower.

This result suggests that a bird might with like effect make use of two collateral currents of different velocity. Suppose two currents, fast and slow, side by side, flowing in the same direction. The bird may fall with the slow current, and so acquire a certain horizontal velocity. Then let it wheel round against the swift current, and it will be able to rise against it to a height due to the greater horizontal velocity between bird and air. Having reached full height, let it again wheel round into the slow current and recover by a sloping descent therein the horizontal velocity it has lost, which, when recovered, will enable it to mount again against the fast current.

Thus it would appear that a bird can take advantage of alternate fast and slow currents, whether collateral or superposed, rising against the fast and falling with the slow, to maintain itself in the air, while partaking in the general drift of the wind, without flapping its wings.

(2.) In the next case to be considered, we have to deal not with horizontal currents, but with the rotatory currents of rolling masses of air. A mass of air rolling about a horizontal axis will have descending currents in its front, and ascending currents in its rear. The former can be of no use to the bird for the purpose of support. The bird must keep in the rear of the roll, where it will find an upward slanting current. In a high wind this current would probably be strong enough to support the bird in motionless poise (relative to the earth), but this could only be for a few seconds, because the whole vortex is travelling rapidly with the wind (of which it forms a part) and would speedily pass and leave the poised bird behind at the mercy of the downward currents in the van of the next advancing vortex. How then is the bird to remain in the upward current, and at the same time to maintain a high velocity relative to the air in which it moves? It can only be done by circling. The bird must face the current in rising, and as it approaches at once the outskirts of the current and the limits of its own momentum (relative to the air) it must wheel round (—indeed it must have begun to wheel while rising—) and fall down the wind, for the double purpose of recovering its spent velocity and of overtaking the receding vortex.

In falling down the wind, the bird will pass out of a stronger into a weaker current, and will be able to take advantage of the difference (regarded horizontally), just as in the case (already considered) of horizontal currents of different velocity. But regarded vertically the descent into the weaker current will be a disadvantage. However, it is clear that under these conditions there will be no difficulty about the bird's support in air by a circling flight without stroke of wing.

But there is still a difficulty with regard to the progressive ascent of the bird. Mr. S. E. Peal (NATURE, vol. xxiii. p. 10) testifies that the pelican, adjutant, vulture, and cyrus rise circling from 100 or 200 to as much as 8000 feet. Can it be supposed that a rolling vortex of air would have equal range or climb to such a height? Swirls formed at the edge of a deep stream of water are seen to be drawn obliquely away from the side towards mid-stream, and I suppose that an aërial vortex with horizontal axis will in like manner be drawn obliquely upwards into the more rapid air. Moreover I remark that Mr. Peal's observations were made on the coast, and that his diagram represents the birds as rising on a wind blowing up the country towards the hills. Such a wind would have a general upward slant, and any rolling of the air would have the same slant to begin with and to rise from, so that a bird keeping to the (supposed) vortex would rise with it to the same height.

The same principles which we have found useful in dealing with the regular and rhythmical phenomenon of circling flight will, I think, help us to understand the general case of irregular sailing flight, like that of the albatross following a ship, as described by so many writers (*e.g.* the Duke of Argyll, "Reign of Law," fifth edition, pp. 153-4). This general case may be accounted for by (1) irregular alternations (either in strength or direction) of horizontal air-currents; or (2) irregular upward currents.

Currents alternating in strength are equivalent, in relation to any intermediate point, to currents alternating in direction.

To take an extreme, almost imaginary, case: let us suppose a bird on outspread wings exposed alternately to the force of exactly opposite winds. To each in turn the bird will offer the sloping under-surface of its wings, and by each in turn it will be at once uplifted and pushed back, but each will counteract the backward push of the other, while each will reinforce the other's uplifting effort. The result will be that the bird will rise in a wavy line without any effort of its own beyond what is required to keep its wings rigid, and to present them favourably to the alternate winds.

Now suppose the whole air to be travelling horizontally in a direction at right angles to the two opposite currents. This supposition will not affect the lifting power of those opposite currents, but it will make it necessary for the bird (if it is not to be swept away by the travelling air) to sacrifice some of the height it might gain for the sake of making head against the general drift of the wind. This is no longer an extreme or imaginary case, but one of very frequent occurrence. It is simply that of oscillating gusts in a high wind. The air is full of sidelong rushes of wind (probably parts of those neighbouring vortices). See how the vane of a weathercock oscillates. A sidelong rush means fresh velocity relative to the bird in a new direction. The bird by a tilt of the wing can instantly convert that fresh air-pressure into a lifting force and rise upon it. And if these rushes of wind come alternately (as in an irregular fashion they are sure to do) from right and left, the bird can take advantage of their alternation to rise higher and higher, or at least to remain floating, without more effort than that which is required to give the due slope to its wings to make the most of every gust.

Next suppose the whole air with its two alternate opposite currents (as above) to be travelling horizontally in the same direction as one of the two opposite currents. Whether this supposition represents a possible state of things I hardly know, but it would correspond in some measure with the commonly observed phenomenon of a succession of alternate gusts and lulls in the wind. Under these conditions, if the air-movement be all horizontal, it is difficult to see how the bird can turn the alternate gusts to advantage, unless it can alternate its own direction accordingly, stemming the gust and wheeling round to fall back with the lull. The bird then would either circle or would follow a wavy course oblique to the direction of the wind. But I imagine that alternate gusts and lulls (as felt, say, at the top of an observatory) are generally caused by a succession of vortices, of which only one phase at a time is present to the observer. These vortices will be infinitely various in the direction of their axes and currents, and it is useless to try and imagine their relative positions. Probably the sea-birds, with their æons of inherited experience, have acquired an instinctive perception of the probable sequences and correlations of air-streams and air-swirls, and are thereby guided so to steer their course, selecting the upward and avoiding the downward currents, as to gain the greatest possible advantage of lifting force that those currents can afford, to the great economy of their muscular strength, which would otherwise have to be spent in the labour of the wing.

In reading of the way in which albatrosses and other large sea birds will follow a ship at sea with little or no flapping of the wings, it has occurred to me that the great obstacle which the ship herself offers to the wind must of necessity give the wind an upward throw and originate a vortex in the air, possibly large enough and persistent enough to be useful to the birds. If the ship be a steamer, the drift of smoke from the funnel will indicate approximately the path of the retiring vortex. It is long since I have had any opportunity of observing, but I well recollect that the gulls used often to be seen in close relation to the smoke that drifted to leeward of the steamer. It is true that any chance morsels of biscuit, &c., thrown from the steamer would probably be thrown to leeward, and this might help to determine the position of the expectant gull.

Again, at sea, the ocean waves themselves, such as roll in from the Atlantic to the Land's End, must throw the wind into rolling vortices, which would afford slant upward currents. The slant, though very flat, might well be sufficient for the purpose of support to the long-winged sea-birds that know how to use it.

On land, countless obstacles impede the lower wind and tend to throw the air into a roll.

Bearing in mind, then, the perpetual variation in strength and direction of current in a high wind, the whirls and gusts, and veering flaws, and seeing how it is possible for the bird to utilise every such variation (except a downward current) to the purpose of its bodily support, we may, I think, obtain some insight into the agency whereby the birds accomplish their marvellous feats of soaring and sailing, upborne upon stiff-strained, motionless wings.

Further observations however are required for the full solution of the problem which I have here only tentatively approached. HUBERT AIRY

Woodbridge, February 28

SOME POINTS IN ELECTRIC LIGHTING[1]

THE science of lighting by electricity was divided by the lecturer into two principal parts—the methods of production of electric currents, and of conversion of the energy of those currents into heat at such a temperature as to be given off in radiations to which the eye was sensible. The laws known to connect together those phenomena called electrical, were essentially mechanical in form, closely correlated with mechanical laws, and might be most aptly illustrated by mechanical analogues. For example, the terms "potential," "current," and "resistance," had close analogues respectively in "head," "rate of flow," and "coefficient of friction" in the hydraulic transmission of power. Exactly as in hydraulics head multiplied by velocity of flow was power measured in foot-pounds per second, or in horse-power, so potential multiplied by current was power and was measurable in the same units. Again, just as water flowing in a pipe had inertia and required an expenditure of work to set it in motion, and was capable of producing disruptive effects if that motion were too suddenly arrested, so a current of electricity in a wire had inertia: to set it moving electromotive force must work for a finite time, and if arrested suddenly by breaking the circuit the electricity forced its way across the interval as a spark. Corresponding to mass and moments of inertia in mechanics there existed in electricity coefficients of self-induction. There was, however, this difference between the inertia of water in a pipe and the inertia of an electric current—the inertia of the water was confined to the water, whereas the inertia of the electric current resided in the surrounding medium. Hence arose the phenomena of induction of currents upon currents, and of magnets upon moving conductors—phenomena which had no immediate analogues in hydraulics.

The laws of induction were then illustrated by means of a mechanical model devised by the late Prof. Clerk Maxwell.

In the widest sense, the dynamoelectric machine might be defined as an apparatus for converting mechanical energy into the energy of an electrostatic charge, or mechanical power into its equivalent electric current through a conductor. Under this definition would be included the electrophorus and all frictional machines; but the term was used in a more restricted sense, for those machines which produced electric currents by the motion of conductors in a magnetic field, or by the motion of a magnetic field in the neighbourhood of a conductor. The laws on which the action of such machines was based had been the subject of a series of discoveries. Oersted discovered that an electric current in a conductor exerted force upon a magnet; Ampere that two conductors conveying currents generally exerted a mechanical force upon each other: Faraday discovered—what Helmholtz and Thomson subsequently proved to be the necessary consequence of the mechanical reactions between conductors conveying currents and magnets—namely, that if a closed conductor moved in a magnetic field, there would be a current induced in that conductor in one direction, if the number of lines of magnetic force passed through the conductor was increased by the movement; in the other direction if diminished. Now all dynamoelectric machines were based upon Faraday's discovery. Not only so; but however elaborate it might be desired to make the analysis of the action of a dynamo-machine, Faraday's way of presenting the phenomena of electromagnetism to the mind was in general the best point of departure. The dynamo-machine, then, essentially consisted of a conductor made to move in a magnetic field. This conductor, with the external circuit, formed a closed circuit in which electric currents were induced as the number of lines of magnetic force passing through the closed circuit varied. Since, then, if the current in a closed circuit was in one direction when the number of lines of force was increasing, and in the opposite direction when they were diminishing, it was clear that the current in each part of such circuit which passed through the magnetic field must be alternating in direction, unless indeed the circuit was such that it was continually cutting more and more lines of force, always in the same direction. Since the current in the wire of the machine was alternating, so also must be the current outside the machine, unless something in the nature of a commutator was employed to reverse the connections of the internal wires in which the current was induced, and of the external circuit. There were then broadly two classes of dynamoelectric machines—the simplest, the alternating-current machine, where no commutator was used; and the continuous-current machine, in which a commutator was used to change the connection with the external circuit just at the moment when the direction of the current would change. The theory of the alternate-current machine was then explained, and it was proved that two independently-driven alternate-current machines could not be worked in series, but that they might be worked in parallel circuit, and hence were quite suitable for distribution of electricity for lighting without the necessity of providing a separate circuit for each machine.

It was easy to see that, by introducing a commutator revolving with the armature, in an alternate-current machine, and so arranged as to reverse the connection between the armature and the external circuit just at the time when the current would

[1] Abstract of lecture delivered at the Institution of Civil Engineers on Thursday evening, April 5, by Dr. John Hopkinson, F.R.S., M.Inst.C.E.

reverse, it was possible to obtain a current constant always in direction; but such a current would be far from constant in intensity, and would certainly not accomplish all the results obtained in modern continuous-current machines. This irregularity might, however, be reduced to any extent by multiplying the wires of the armature, giving each its own connection to the outer circuit, and so placing them that the electromotive force attained a maximum successively in the several coils. A practically uniform electric current was first commercially produced with the ring armature of Pacinotti, as perfected by Gramme. A dynamo-machine was not a perfect instrument for converting mechanical energy into the energy of electric current. Certain losses inevitably occurred. There was the loss due to friction of bearings, and of the collecting-brushes upon the commutator; there was also the loss due to the production of electric currents in the iron of the machine. When these were accounted for, there remained the actual electrical effect of the machine in the conducting wire; but all of this was not available for external work. The current had to circulate through the armature, which inevitably had electrical resistance; electrical energy must therefore be converted into heat in the armature of the machine. Energy must also be expended in the wire of the electromagnet which produced the field, as the resistance of this also could not be reduced beyond a certain limit. The loss by the resistance of the wires of the armature and of the magnets greatly depended on the dimensions of the machine. To know the properties of any machine thoroughly, it was not enough to know its efficiency and the amount of work it was capable of doing; it was necessary to know what it would do under all circumstances of varying resistance or varying electromotive force; and, under any given conditions, what would be the electromotive force of the armature? Now this electromotive force depended on the intensity of the magnetic field, and the intensity of the magnetic field depended on the current passing round the electromagnet and the current in the armature. The current then in the machine was the proper independent variable in terms of which to express the electromotive force. The simplest case was that of the series-dynamo, in which the current in the electromagnet and in the armature was the same, for then there was only one independent variable. The relation between electromotive force and current might be most conveniently expressed by a curve.

When four years ago the lecturer first used such a curve (since named by Deprez the "characteristic curve") for the purpose of expressing the results of his experiments on the Siemens dynamo-machine, he pointed out that it was capable of solving almost any problem relating to a particular machine, and that it was also capable of giving good indications of the results of changes in the winding of the magnets, or of the armatures of such machines The use of the characteristic curve was illustrated with reference to charging accumulators and Jacobi's law of electric transmission of power.

When the dynamo-machine was not a series-dynamo, but the current in the armature and in the electromagnet, though possibly dependent upon each other were not necessarily equal, the problem was not so simple. In that case there were two variables, the current in the electromagnet and the current in the armature; and the proper representation of the properties of the machine would be by a characteristic surface, of which a model was exhibited. By the aid of such a surface any problem relating to a dynamo-machine could be dealt with, no matter how its electromagnets and its armature were connected together. Of course in actual practice the model of the surface would not be used, but the projections of its sections.

The properties of a machine depended much upon its dimensions. Suppose two machines alike in every particular, excepting that the one had all its linear dimensions double that of the other. The electrical resistances in the larger machine would be one-half those of the smaller. The current required to produce a given intensity of magnetic field would be twice as great in the larger machine as in the smaller. The comparative characteristic curves of the two machines when driven at the same speed were shown in a diagram. The two curves were one the projection of the other, having corresponding points with abscisses in the ratio of one to two, and the ordinates in the ratio of one to four. At first sight it would seem that the work done by the larger machine should be thirty-two times as much as that which would be done by the smaller. Practically, however, no such result could possibly be attained for many reasons. First, the iron of the magnets became saturated, and consequently, instead of eight times the electromotive force, there would only be four times the electromotive force. Secondly, the current which the armature could carry was limited by the rate at which the heat generated in the armature could escape. Again, the larger machine could not run at so great an angular velocity as the smaller one. And lastly, since in the larger machine the current in the armature was greater in proportion to the saturated magnetic field than in the smaller one, the displacement of the point of contact of the brushes with the commutator would be greater. Shortly, the capacity of similar dynamo-machines was pretty nearly proportionate to their weight, that was to the cube of their linear dimensions; the work wasted in producing the magnetic field was directly as the linear dimensions; and the work wasted in heating the wires of the armature was as the square of the linear dimensions.

A consideration of the properties of similar machines had another important practical use. Mr. Froude was able to control the design of ironclad ships by experiments upon models made in paraffin wax. It was a much easier thing to predict what the performance of a large dynamo-machine would be, from laboratory experiments made upon a model of a very small fraction of its dimensions. As a proof of the practical utility of such methods, the lecturer stated that by laboratory experiments he had succeeded in greatly increasing the capacity of the Edison machines without increasing their cost, and with a small increase of their percentage of efficiency, remarkably high as that efficiency already was.

The electric properties of the electric arc were experimentally illustrated; in particular it was shown that the difference of potential between the carbons was nearly independent of the current.

When a current of electricity passed through a continuous conductor it encountered resistance, and heat was generated, as shown by Joule, at a rate represented by the resistance multiplied by the square of the current. If the current was sufficiently great, heat would be generated at such a rate that the conductor would become incandescent and radiate light. Attempts had been made to use platinum and platinum iridium as the incandescent conductor. But these bodies were too expensive for general use, and besides that, refractory though they were, they were not refractory enough to stand the high temperature required for incandescent lighting, which should be economical of power. Commercial success was not realised until very thin and very uniform threads or filaments of carbon were produced and inclosed in reservoirs of glass, from which the air was exhausted to the utmost possible limit. Such were the lamps made by Mr. Edison with which the Institution was temporarily lighted. The electrical properties of such a lamp were examined, and in particular it was shown that its efficiency increased and its resistance diminished with increase of current.

The building was lighted by about 230 lamps, each giving sixteen candles light, produced each by 75 Watts of power developed in the lamp. To produce the same sixteen candles' light in ordinary good flat-flame gas-burners, would require between 7 and 8 cubic feet of gas per hour, contributing heat to the atmosphere at the rate of 3,400,000 foot-pounds per hour, equivalent to 1250 Watts, or nearly seventeen times as much heat as the incandescence lamp of equal power.

At the present time, lighting by electricity in London must cost something more than lighting by gas. What were the prospects of reduction of this cost? Beginning with the engine and boiler, the electrician had no right to look forward to any marked and exceptional advance in their economy. Next came the dynamo, the best of these were so good that there was little room for economy in the conversion of mechanical into electrical energy; but the prime cost of the dynamo-machine was sure to be greatly reduced. Hope of considerably increased economy must be mainly based upon probable improvements in the incandescence lamp, and to this the greatest attention ought to be directed. It had been shown that marked economy of power could be obtained by working the lamps at high pressure, but then they soon broke down. In ordinary practice, from 140 to 200 candles were obtained from 1 horse-power, developed in the lamps, but for a short time he had seen over 1000 candles per horse-power from incandescence lamps. The problem, then, was so to improve the lamp in details, that it would last a reasonable time when pressed to that degree of efficiency. There was no theoretical bar to such improvements, and it must be remembered that incandescence lamps had only been articles of commerce for about three years, and already much had been done. If such an improvement were realised, it would mean that it would be possible to get five times as much light for a sovereign as could be done now. At present electric lighting would succeed commercially where other considerations than cost had weight. Improvements in the lamps were certain, and there was a probability that these improvements might go so far as to reduce the cost to one-fifth of what it now was. He left the meeting to judge whether or not it was probable, nay, almost certain, that lighting by electricity was to be the lighting of the future.

HARDENING AND TEMPERING STEEL

ONE of a series of lectures to the Liverymen and Apprentices of the Company of Cutlers of London was delivered on Thursday last by Prof. W. Chandler Roberts, F.R.S., "On some Theoretical Considerations connected with Hardening and Tempering Steel."

The Master of the Company, Mr. J. Thorne, presided, and the Lecturer observed that the phenomena with which they had to deal, although admittedly as interesting and remarkable as any in the whole range of metallurgy, are but little understood.

If the fact that steel can be hardened had not been known, the whole course of our industrial and even political history would probably have been widely different, and the dagger, which occupies so prominent a place in the armorial bearings of the City of London, would have represented a survival of implements made, not of steel, but of copper hardened with tin.

It has long been known that there are extraordinary differences between the properties of wrought iron, steel, and cast iron, but our knowledge that these differences depend upon the presence or absence of carbon is only a century old, for it was not until the year 1781 that Bergman, Professor in the University of Upsala, showed that wro ght iron, steel, and cast iron, when dissolved in certain acids, leave amounts of a graphitic residue, varying from $\frac{1}{10}$ to $2\frac{1}{2}$ per cent., which are essential to the constitution of these three varieties of metal. Bergman's work led many early experimenters, notably Clouet in 1796, to attempt to establish the importance of the part played by carbon, and Clouet converted pure iron into steel by contact at a high temperature with the diamond, which was the purest form of carbon he could command. Prof. Roberts said that this experiment had been repeated by many other observers with varying success, as in all the earlier work the furnace gases, which had not been excluded, might have converted the iron into steel without the intervention of the diamond. It remained for a distinguished Master of the Cutlers' Company, Mr. W. H. Pepys, to repeat Clouet's fundamental experiment under conditions which rendered the results unequivocal, by employing electricity as a source of heat. This experiment, which had been communicated to the Royal Society in 1815, was performed in the way Pepys had indicated.

It was then shown that in soft, tempered, and hardened steel respectively the carbon has a distinct "mode of existence," as is indicated by the widely different action of solvents on the metal in these three states.

The evidence as to whether carbon in steel is *combined* in the chemical sense, or is merely *dissolved*, was then considered at some length, special reference being made to the results obtained by various experimenters, from Berzelius and Karsten to Sir Frederick Abel of the War Department.

Prof. Roberts stated that the researches of Troost and Hautefeuille afforded strong evidence that in "white cast-iron" and steel the carbon is merely dissolved, a view which he adopted, as he did not consider it to be at all in opposition to the facts recently established by Sir Frederick Abel, who had shown that the carbon may be left by the slow action of solvents on soft steel as a carbide of iron.

The various physical, as distinguished from the chemical theories that had been propounded from the time of Réaumur, (1722) to that of Akerman (1879), to account for the "intimacy of the relation" of carbon and iron in hard as compared with soft steel, were then described at some length, and the remarkable experiments of Réaumur, who cooled steel slowly in a Torricellian vacuum in order to show that the absorption of gas did not take place during cooling, was illustrated.

In recent years much importance has been attached to the physical evidence as to the peculiar constitution of steel, and it has been shown that there is a remarkable relation between the amount of carbon contained in different varieties of steel and their electrical resistance. Some of the very interesting experiments of Prof. Hughes on this point were then exhibited and described, and Prof. Roberts concluded by saying that the value of the early work by Bergman and Réaumur had rather been lost sight of in recent discussions, Bergman's work being specially remarkable, as he attempted, by thermometric measurement, to determine the heat equivalent of the phlogiston he believed iron and steel to contain.

The importance of the degree of carburisation of steel from the point of view of its technical application was illustrated by reference to a series of curves, and it was incidentally mentioned that, in the case of the variety of steel used for the manufacture of coinage-dies, the presence of $\frac{1}{10}$ per cent. of carbon more or less than a certain standard quantity makes all the difference in the quality of the metal.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The new Board of the Faculty of Natural Science has issued its first list of lectures this term. The lectures are divided under the following heads:—Physics, Chemistry, Animal Morphology, Geology, and Botany. No lectures are scheduled this term under Mineralogy or Physiology.

In Physics Prof. Clifton lectures on "Instruments and Methods of Measurement employed in the Study of Optics." These lectures are given in the Clarendon laboratory, where practical instruction in Physics is given by the Professor, assisted by Messrs. Stocker and Heaton. At Christ Church Mr. Baynes lectures on Electrokinematics and Electrodynamics, and gives practical instruction on Electric and Magnetic Measurements. At Balliol Mr. Dixon gives a course of experimenta lectures on Elementary Heat and Light.

In Chemistry Dr. Odling lectures at the Museum on the Composition of Air and Water; Mr. Fisher lectures on Inorganic Chemistry; and Dr. Watts on the Cyanogen Series. At Christ Church Mr. Harcourt has a class for Quantitative Analysis, and Mr. Dixon a class for Gas Analysis.

In Animal Morphology Prof. Moseley lectures on Comparative Anatomy, and gives practical instruction to his class after each lecture; Mr. Hickson lectures on the Development of the Chick, Mr. Hatchett Jackson on Mammalian Osteology and the Principles of Embryology, Mr. Poulton on the Distribution of Animals, and Mr. Lewis Morgan on the Vertebrate Exoskeleton and on Human Osteology.

In Botany Mr. Chapman gives practical instruction on Vegetable Morphology at the Botanic Gardens.

In Geology Prof. Prestwich will give a series of lectures on Friday afternoons on the strata and fossils to be visited on his Saturday excursions.

On June 19 an examination will be held in common by Magdalen, Merton, and Corpus Christi Colleges for electing a Scholar in Physical Science at each College. At Merton and Corpus the chief subjects will be Chemistry and Physics.

Jesus College offers a Welsh Scholarship in Natural Science. The examination will be held on June 14.

Examinations for the degree of Bachelor of Medicine (both First and Second) will be held this term. Candidates are to send in their names before May 1.

CAMBRIDGE.—Prof. Huxley's Rede Lecture at Cambridge University will be given on June 12, at 3 p.m., in the Senate House. The subject is not yet announced.

Dr. Michael Foster leaves the Lectures on Elementary Biology for this term in the hands of Dr. Vines and Mr. Sedgwick, and will hold Catechetical Classes in Physiology for the Natural Sciences Tripos.

Dr. F. Darwin will give six Demonstrations on the Physiology of Plants (Growth, Movement, &c.) at the Physiological Laboratory on Saturdays at noon, beginning April 21.

Prof. Liveing will lecture on the Chemistry of the Heavenly Bodies, beginning May 1.

LONDON.—Mr. A. H. Keane has been appointed to the Hindustani Lectureship at University College.

THE Winter Session at the College of Agriculture, Downton, near Salisbury, ended on Monday, when the certificates and prizes were presented to the successful students by Archdeacon Sanctuary. The certificate of membership, obtainable on examination after completion of the two years' course of study, was granted to Mr. Arthur Herbert Kerr, Crookham, Farnham, and to Mr. Henry Blair Mayne, Brantridge Park, Balcombe. The Scholarship, open to first-year students, was awarded to Mr. Robert Alan Benson, Clifton.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, April 12.—Prof. Henrici, F.R.S., president, in the chair.—The Chairman announced that Prof. Rowe, of University College, London, had been elected a Member of the Council in the room of the late Prof. Henry Smith, F.R.S.—The following communications were made:—Equations of the loci of the intersections of three tangent lines and of three tangent planes to any quadric $u = 0$, Prof. Wolstenholme.—Investigation of the character of the equilibrium of an incompressible heavy fluid of variable density, Lord Rayleigh, F.R.S.—On the normal integrals connected with Abel's theorem, Prof. Forsyth.—Spherical functions, Part 1, Rev. M. M. U. Wilkinson.—Calculation of the equation which determines the anharmonic ratios of the roots of a quintic, Prof. M. J. M. Hill.—On simultaneous differential equations, with special reference to (1) the roots of the fundamental determinant, (2) the method of multipliers, Mr. E. J. Routh, F.R.S.

Chemical Society, April 5.—Dr. W. H. Perkin, president, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (April 19).—The following papers were read:—On the estimation of hydrogen sulphide and carbonic anhydride in coal-gas, by L. T. Wright. The coal-gas, dried and freed from ammonia, is passed through two weighed U-tubes, the first containing precipitated cupric phosphate dried at 100° and calcium chloride, the second, soda lime, slightly moist, and calcium chloride. Three cubic feet of clean coal-gas are first passed through the U-tubes to "saturate" the reagents. The increase of weight of the first U-tube, after the passage of the crude coal-gas, then gives the hydrogen sulphide, and the increase in weight of the second the carbonic anhydride.—Some compounds of antimony and bismuth containing two halogens, by R. W. Atkinson.—On the theory of a molecular combination, when antimonious chloride is mixed with potassium bromide and antimonious bromide with potassium chloride, two distinct compounds should be produced. The author finds that but one is formed, the two compounds being identical in composition as well as in colour, crystalline form, and other physical characters. This body has the formula $Sb_2Cl_6Br_6K_6 + 3H_2O$. An attempt to form the corresponding bismuth compound was not successful.—Contribution to the chemistry of the cerite metals, by B. Brauner. The author has determined the atomic weight of didymium with the greatest care, and fixes it at 145·4; the higher numbers previously obtained were due to the presence of a metal having a higher atomic weight; this metal is proved by the author to be samarium, the atomic weight of which he calculates to be 150. The author also proves that the principal gadolinite earths—yttria, terbia, erbia, &c.—are present in cerite, but not in large quantities.

Institution of Civil Engineers, April 3.—Mr. Brunlees, president, in the chair.—The paper read was "On the Summit-Level Tunnel of the Bettws and Festiniog Railway," by Mr. William Smith, M.Inst.C.E.

April 10.—Mr. Brunlees, president, in the chair.—The paper read was on "The Introduction of Irrigation into New Countries, as illustrated in North-Eastern Colorado," by Mr. P. O'Meara, M.Inst.C.E.

EDINBURGH

Royal Society, April 2.—Mr. John Murray in the chair.—Dr. Gibson, in a communication on some laboratory arrangements, described and exhibited a modification of Bunsen's method of filtration. The modification consisted essentially in placing the vessel which received the filtrate inside a bell-jar, which was connected with the exhausting apparatus and perforated above so as to admit the funnel through which the liquid filtered. By a suitable three-way stopcock arrangement the adjusting of the internal partial vacuum was kept quite under the control of the experimenter. A contrivance for the more convenient use and better preservation of sulphuretted hydrogen water was also described and shown.—Prof. Tait, in a short note on the thermoelectric position of pure cobalt, described recent experiments which fully bore out results formerly obtained with other specimens. The cobalt line runs nearly parallel to the iron line, but far down on the diagram below palladium and nickel. Prof. Tait also indicated the solution of certain problems of heat conduction in heterogeneous bodies as affected by the Peltier and Thomson effects.—Prof. George Forbes read a paper on transmission of power by alternate currents, in which he pointed out the value of alternate current machines as electromotors, especially in cases in which perfect isochronism was of importance.—Prof. Herdman, in a paper on the so-called hypophysis in the Tunicata, described the structure of the neural (hypophysal) gland and the dorsal tubercle in various Ascidians, and suggested that possibly the connection of the neural gland (and also of the vertebrate hypophysis cerebri) with the pharynx might be a secondary modification caused by one or more of a series of primitive lateral excretory ducts, opening either upon the exterior of the body or into the peribranchial cavity, having come to open into a lost sense organ, in the Stomodæum represented by the dorsal tubercle. These lateral ducts are found in *Ascidia mammillata*, in some cases existing along with a median duct opening into the pharynx at the dorsal tubercle, and in other cases without this connection with the supposed sense-organ.—Prof. Tait presented a paper on the quaternion expression for the displacements of a rigid system, by Dr. G. Plarr.

Mathematical Society, April 13.—Mr. A. J. G. Barclay, M.A., in the chair.—Mr. J. S. Mackay, president, read a paper on the triangle and its six-scribed circles, adding historical notes on the discovery of the various properties enumerated. The name *medioscribed* circle (il circolo medioscritto) was suggested for use instead of nine-point circle, as had been proposed twenty years ago by G. B. Marsano, "Considerazioni sul Triangolo Rettilineo," Genova, 1863, p. 11.

BERLIN

Physiological Society, March 9.—Prof. Du Bois Reymond in the chair.—Dr. Wernicke gave a short sketch of the illness of a patient who fell sick, exhibiting all the symptoms of a cerebral tumour except epileptic attacks, and who manifested a disturbance of speech that was characterised by Dr. Wernicke as a "sensorial aphasia," and by others as "word-deafness." A sensorial aphasia consists, according to Dr. Wernicke, in the fact that the patients, though in possession of a large vocabulary, no longer understand the meaning of words, that they use these confusedly, and so that their speech is quite muddled; moreover they do not understand what one says to them at all, so that it is impossible to arrive at an understanding with them. The patient in question soon succumbed to an intercurrent disease, and it was possible to make a thorough dissection of the brain, which exhibited a bilateral affection of the cerebral cortex at the first temporal convolution. An accurate dissection of the ears showed that the deafness that had been observed during life was not brought about by any disease of the sound-conducting apparatus, but that it was rather to be regarded as a central deafness conditioned by the disease of the cortex of the first spheno-semporal convolution in which, as Dr. Wernicke made probable to long as ten years ago, the terminal expansion of the acoustic nerve has its seat. Now the local disease of the brain-cortex and the consequent observed disturbances in hearing and speech correspond to the manifestations of "soul-deafness" that were experimentally produced by Dr. Munk in animals by extirpation of the auditory sphere (*Hörsphäre*), and consequently establish the results of experiments on animals as true for man also. The total deafness of the patient had only set in at a later period towards the end of the disease, when the affection of the brain had passed from the cortex into the deeper structures and had destroyed the acoustic fibres. The physiological import of the above case consists in the clearly proved limitation of the disease to the first temporo-sphenoidal convolution in a case where the clinical phenomena corresponded accurately to those of "soul-deafness."—Dr. J. Munk had found in previous experiments that the function of neutral fats in nutrition can just as well be performed by the fatty acids. Animals manifested absolutely no disturbance of nutrition when supplied with fatty acids instead of fats; the fatty acids were made into an emulsion, and absorbed by the villi in precisely the same fashion as the fats, and afterwards the chyle-vessels were found just as densely filled with a milky fluid as after a meal of fat. The examination of the chyle had, however, shown that the fatty acids that were supplied were no longer to be found, but only neutral fats, and hence Dr. Munk had assumed that a synthesis of neutral fats took place as the fatty acids passed out of the intestinal villi into the chyle, and that the glycerine was supplied by the animal body, probably by the breaking down of albumen. Dr. Munk has only just lately been able to advance a proof of the truth of this assumption of a synthesis of neutral fat out of fatty acids after it had been shown by other observers that heterogeneous neutral fats could be taken up by animals and also be deposited as such in the body. Dr. Munk now fed a dog, which had been greatly reduced in weight by prolonged starvation, with large quantities of the fatty acids of mutton and with a little lean meat. The animal very soon increased considerably in weight upon this diet, and after fourteen days had deposited 1100 grms. of fat in various organs under the skin, in the mesentery, in the heart, and in the liver. Analysis of this fat elicited the fact that it consisted of at least 96 per cent. of neutral mutton fat. And in the dog it is evident that the mutton fat could only have arisen by a synthesis of the fatty acids of mutton that were eaten.

PARIS

Academy of Sciences, April 9.—M. Blanchard in the chair.—The following papers were read:—On charbonous vaccination, by M. Pasteur. Some Turin professors having found that vaccinated as well as unvaccinated sheep died after virulent inoculation, M. Pasteur made inquiry, and came to the conclusion that the blood used for such inoculation was septic as well as charbonous (the sheep was dead twenty-four hours before its blood was taken). He challenges the Turin men to a test of this.—Description of a means of obtaining a wholly automatic action of the sluice with oscillating liquid columns, without cataract; experimental realisation of this system during the emptying of the sluice of l'Aubois, by M. de Caligny.—Units of mechanics and of physics, by M. Ledieu.—The salt lands of the South-East, by M. de Gasparin. The problem of freeing such ground from salt is (unlike the formation of a *polder*) an indeterminate one, and may be insoluble; many years' submersion and drainage may be ineffectual.—Report on electrodynamic machines applied to the transmission of mechanical work, by M. Marcel Deprez. The dynamometric return (viewed apart from the mechanical motor) was over 48 per cent.—On surfaces with *nil* mean curvature, on which may be limited a finite portion of the surface by four straight lines situated on the surface, by M. Schwarz.—A letter of invitation to the Institute to the second session of the Royal Society of Canada at Ottawa, on May 22, was read.—Observation of the transit of Venus at Punta-Arenas (Straits of Magellan), by M. Cruls. The four contacts were observed under excellent conditions.—Observations of the Swift-Brooks comet, by M. Périgaud.—Observations of comet II., 1882, at Algiers Observatory, by M. Trépied.—On uniform functions affected by sections, and on a class of linear differential equations, by M. Appell.—Law of periods, by M. de Jonquières.—Remarks on the primitivity of groups, by M. Dyck.—Determination of arithmetical progressions, whose terms are only known approximately, by M. Lucas.—On a theorem of M. Stieltjes, by M. Cesaro.—On an improvement applicable to the Jonval turbine, by M. Léauté.—On the radiation of silver at the moment of solidification, by M. Violle. The radiation decreases at first, more or less rapidly; then the decrease slackens, and when solidification begins at the border of the vessel, there is a slight increase: till solidification reaches the central part the radiation of the liquid remains constant, then there is slight increase, followed by rapid decrease.—On several optical apparatuses for testing plane surfaces, parallel, perpendicular, and oblique, by M. Laurent.—Very powerful direct-vision spectroscope, by M. Zenger. By adding to the dispersion parallelipiped a light crown glass prism, he gets a dispersion of 150° (A to H); this is surpassed only by M. Thollon's spectroscope, in which the number of sulphide of carbon prisms and the multiple reflections diminish greatly the intensity of the light.—On the upper limit of the perceptibility of sounds, by M. Pauchon. He used a steam-driven syren, also metallic rods of diminishing length fixed at one end, and rubbed. *Inter alia*, an acoustic cornet slightly removed the limit of perceptibility; exciting the rods with various substances (colophany, alcohol, &c.) also changed the limit-length, sometimes to the extent of double. A sound that had become too high for the ear still acted on a sensitive flame.—On a process for obviating boiler explosions, by M. Trèves. He recommends a thermomanometer, and a methodic feeding according to it; also the introduction of a tube for injection of air.—On some experiments made with dynamoelectric machines, by M. Pollard.—Reply to M. Reynier, by M. Trouvé.—Production of crystalline vanadates by the dry way, by M. Ditte.—Action of sulphur on alkaline phosphates, by MM. Filhol and Senderens.—On a combination of phosphoric acid and silica, by MM. Hautefeuille and Margottet. The formula is PhO_5SiO_2.—On various kinds of borotungstates, by M. Klein.—Application of the phenomena of supersaturation to the theory of hardening of some cements and mastics, by M. Le Chatelier.—On chloride of pyrosulphuryl, by M. Konowaloff.—On the difference of reactional aptitude of halogen bodies in mixed halogen ethers; first part, ethylenic compounds, by M. Henry.—On liquid chlorhydrates of turpentine, by M. Barbier.—The structure of the ovary and formation of eggs in the Phallusiadeæ, by M. Roule.—On the organs of flight in insects, by M. Amans. In both theories of flights he considers (M. Marey's and Mr. Pettigrew's) it is overlooked that the base of the wing is formed of two planes, with obtuse angles, so that in the descending stroke the posterior plane presents its concavity to the column of air struck; the resultant, on the two axillæ, raises the bird.—On the trichomatic origin and formation of some cystoliths, by M. Chareyre.—Physiological researches on Champignons, by MM. Bonnier and Mangin. The ratio of oxygen absorbed to carbonic acid emitted does not vary sensibly with the temperature in a given species. Respiration increases very sensibly with the hygrometric state of the air, diminishes in diffused light, is greatest in the more refrangible rays. Transpiration is greater in diffuse light than in darkness.—Scientific exploration in the Straits of Magellan, on Terra-del-Fuego, and on the coast of Patagonia, with the Brazilian corvette *Parnahyba*, by M. Cruls.—The perception of colours and the perception of differences of brightness, by M. Charpentier. The perception of colour is merely the appreciation of the difference of excitation, by certain rays, of the apparatus of luminous sensibility on the one hand, and of that of visual sensibility, or distinction of forms, on the other.—Experimental researches on the physiological effects of cinchonidine, by MM. Sée and Bochefontaine. Its place (with quinine and cinchonine) is among substances which depress the nervous system after momentary stimulation of the circulation.—On the effects of prolonged stay in an atmosphere charged with vapours of creosote, by M. Poincaré. There was hardening of the brain, sclerosis of liver and kidneys, effacement of the pulmonary cavities, &c.—On the circulation of the fingers and derivative circulation of the extremities, by M. Bourceret. In the last phalanx of the fingers there is a special arrangement for rapid return of the blood; it consists of large, very short capillaries, and is merely a modification of the general type. One cannot speak properly of a derivative circulation.—On the attenuation of the virulence of the bacterium of charbon by antiseptic substances, by MM. Chamberland and Roux. This was proved with carbolic acid and bichromate of potash.

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