THURSDAY, SEPTEMBER 5, 1901.

PETROLEUM.

Handbook on Petroleum. By Captain J. H. Thomson and Boverton Redwood. Pp. xix+298. (London: Charles Griffin and Co., Ltd., 1901). Price 8*s*. 6*d*.

THE cooperation of Captain Thomson, H.M. Chief Inspector of Explosives, and Mr. Boverton Redwood, author of the encyclopædic "Treatise on Petroleum," in producing a handbook on the subject for the use, not only of officers of local authorities charged with the duties prescribed by the Petroleum Acts, but also of those engaged in the petroleum trade, strikes us as peculiarly happy.

The handbook commences with a short historical introduction, and the authors then proceed to a brief exposition of the theories of the origin of petroleum.

Whereas French and Russian chemists have supported the inorganic origin, a theory which in outline regards the oil as formed by the condensation under pressure of the gases generated by the action of water-vapour on metallic carbides, American geologists and German chemists favour the organic origin of petroleum.

Berthelot and Mendeleeff give the weight of their authority to the first theory, but there seems to be but little doubt that, though it is possible to produce petroleum in this manner, the organic origin is at once more probable and agrees better with the deductions of the geologist.

The supporters of the organic theory are also divided. The school of German theorists, among whom the names of Hofer and Engler stand out prominently, consider petroleum to be of purely animal origin, whereas many American geologists consider certain types, such as the oil of Pennsylvania, to be of vegetable origin.

At the meeting of German men of science and physicians at Munich in 1899, Krämer brought forward the view that petroleum is formed by the decomposition, under pressure, of the wax at the bottom of lakes and seas, which originated in the cells of diatoms; infusorial earth, which consists of the skeletons of Bacillariaceæ, exists in beds of enormous extent in districts where petroleum is found. In the discussion which followed, Engler, whilst admitting that some oil might be formed in this manner, upheld his view that petroleum is primarily derived from the submarine decomposition of fish, substantiating his theory by the announcement that he had found and analysed drops of petroleum from fossil bivalves in the Lias at Rothmatsch: we shall, however, be wisest to consider at present, with the authors of this book, petroleum to be of mixed animal and vegetable origin.

The next chapters are occupied by an account of the sources of supply, by a description of the methods for the production, refining and transport (the value of this section would have been considerably enhanced by diagrams and drawings), and by the enumeration of the names and chief properties of the commercial products of petroleum. Among much other useful information, the difference between "benzene," "benzine," "benzol" and "benzoline" is clearly explained. The next two chapters are devoted to "flash-point" and "fire-test."

The term "flash-point," as defined by the Act of 1879, has given rise to much misconception; it is not "the point at which petroleum gives off an inflammable vapour," but the temperature at which the oil gives off sufficient vapour to form an inflammable mixture with the air, a matter which, as the authors remark, depends entirely on the experimental conditions.

A considerable uniformity was obtained by the adoption (Act of 1879) of the Abel test, but the apparatus is capable of considerable improvement, and this improvement is met with in the Abel-Pensky test, a modification adopted by the German Government, the use of which the authors hope will shortly be legalised in this country. As the flash-point is lowered 1·6° F. for every reduction of an inch in barometric pressure, it is important to introduce a correction depending on the height of the barometer; such a table of corrections is given in this handbook and is used in Germany, but has not as yet received the sanction of Parliament. The Abel and Abel-Pensky tests are described with great detail and clearness, as is also the elegant method for ascertaining the presence of small quantities of petroleum vapour devised by one of the authors, namely by the use of the Redwood test-lamp, the principle of which depends on the halo or "flame-cap" which surrounds the hydrogen flame when burning in an atmosphere containing a small proportion of inflammable gas—the appearance of the flame under these conditions is illustrated by an excellent coloured photograph, and the diagrams throughout this section are most useful.

The rest of the book is occupied by an account of the legislation relating to petroleum and calcium carbide, including the precautions to be taken in the storage of the oil, and remarks on the construction of petroleum lamps. This section, which, like the rest of the book, is extremely clearly written, should be studied by all oil-dealers, lamp-manufacturers and local authorities; we venture to think its perusal would repay "the man in the street."

The law with regard to petroleum in force at the present time is contained in the Petroleum Acts of 1871, 1879, and 1881, but the history of petroleum legislation is one of "laborious attempt and discouraging failure." Subsequent to the Act of 1881, a Bill of fifty-seven clauses was introduced (in 1883) and referred to a Select Committee of the House of Lords; this was followed by a tour of inspection and the drafting, in 1884, of a second Bill, followed in its turn by an extension of the tour to America. In 1888 important conferences were held and memoranda presented to both Houses; the inevitable Bill was introduced in 1891 and a Select Committee appointed in 1894, which was reappointed in 1896 and 1897 and which reported in 1898. In 1899 Mr. Reckitt, a member of the committee, introduced a private Bill to raise the flash-point from 73° F. to 100° F. (Abel test). The Bill was defeated, but the "lobbying" on this occasion was such as to induce Mr. Healy to express wonder whether "all this was pure philanthropy."

The authors proceed to consider the reasons for this want of success. The present Acts are by no means unworkable, and have the merit of simplicity; but they simply control the keeping of petroleum spirit (oil flashing below 73° F.) and in no way interfere with the sale or storage of petroleum oil (oil flashing above 73° F.).

Though the Acts leave everything to the local authority, yet they are deficient in provision for local control; the excessive decentralisation which puts in the hands of district councils throughout the kingdom the administration of such technical legislation cannot but militate against the attainment of the object in view. But the legislative failure is not due to these minor points, but rather to the strong opposition to the raising of the flash-point and to the attempt to prohibit dangerous lamps by legal enactment.

The objections to raising the flash-point are, firstly, that it is uncertain whether this measure would have an appreciable effect in preventing lamp accidents, which are, as a general rule, not caused by explosions, but by over-heating of the gallery and wick-tube and by breaking the lamp, in which cases no oil flashing under 150° F. can be regarded as absolutely safe; and, secondly, that raising the flash-point would indubitably cause a rise in the price of the oil, when there would be tendency to supply petroleum spirit for lighting purposes, this spirit commanding, under present conditions, a higher price than petroleum oil. The administrative difficulty of the prohibition of dangerous lamps must be patent to everybody.

The yearly average of fatal accidents from lamps is 129, and this period represents the lighting, burning and extinguishing of a lamp at least 4,000,000,000 times; now during a similar period, 5500 deaths are caused by falling down stairs, yet no one would suggest that in consequence houses must be restricted to one story; lamp accidents are nearly always caused by lamps being dropped, knocked over or pulled off tables when lighted and occasionally a lighted lamp is used as a missile.

The authors give much sound advice as to the purchase of safe lamps and, in an appendix, add directions for the care and use of petroleum lamps, the circulation of which recommendations in leaflet form by local authorities would doubtless be attended by beneficial results. The concluding chapter is devoted to calcium carbide and acetylene.

The first appendix deals with the imports of petroleum, from which it appears that the import of Russian oil is increasing, whereas that of American is decreasing—the enormous increase in the importation of "petrol," motor-car spirit, is significant; in other appendices the Petroleum Acts of 1871, 1879, and 1881 are given, with comments and explanatory notes; memoranda and forms of license issued by the London County Council and a County Council report on the use of petroleum in manufactures and trades in London are also printed.

The book is well printed, clearly arranged, and possesses a good table of contents and an index; we must warmly congratulate its authors on having produced an altogether admirable handbook of the subject.

W. T. Lawrence.

COMMERCIAL EDUCATION.

Commercial Education at Home and Abroad: a Comprehensive Handbook, providing materials for a Scheme of Commercial Education for the United Kingdom, including Suggested Curricula for all Grades of Educational Institutions. By Frederick Hooper and James Graham. Pp. xiv + 267. (London: Macmillan and Co., Ltd., 1901.) Price 6*s*.

THE joint authors of this book are respectively the secretary of the Bradford Chamber of Commerce and the inspector for commercial subjects and modern languages to the West Riding County Council. They have done well to embody the results of their experience in a volume in which the promise held out in its somewhat lengthy title is creditably fulfilled. Very copious particulars are given in regard to the organisation and plans of commercial schools in the chief countries of Europe, notably France, Germany, Belgium and Switzerland. Designs of buildings, regulations and time-tables, both from these countries and from the United States of America, show in considerable detail how ample and varied is the provision made for the systematic teaching of "commercial" subjects, and how much our own countrymen have yet to learn in this department of national education. A considerable portion of the book is thus statistical and is made up of a great variety of official documents; but it is uncritical, and does not profess to do more than set forth existing facts, without discriminating very exactly between those portions of an elaborate programme which are of merely occasional and local importance and those which are entitled to rank as essential in every complete scheme of commercial and economic training.

In dealing with the conditions under which our own tentative efforts after such training have hitherto been made, the authors write with the authority which comes from intimate knowledge, and their suggestions are of much practical value. They rightly insist on the need of a good foundation of general knowledge before any attempt is made to differentiate the course of a boy's instruction in the direction of any trade or profession. But they urge that when the time for such differentiation arrives, there should be as much encouragement offered by public authorities to the training of skilled merchants as to the education of the skilled manufacturer or artisan. The policy of the Education Office, and the award of special grants and recognition for "Science and Art," have helped to encourage a general belief that all efforts to prolong the education of a youth beyond the ordinary school age and to fit him for the practical business of life should take a scientific direction, the domain of "science" being understood to include chemistry, physics and other studies bearing on material industries and production. "At present," the authors say, "provision is made whereby the science student may specialise in the direction of mechanical and electrical engineering, chemical industries and textile trades. But for the commercial student no such opportunity exists."

The contention that this is too restricted a view of the aims and scope of a technical or continuation school is, in our opinion, well grounded, and ought to lead to a fuller official recognition of the need for variety in Polytechnics and other institutions which do not come necessarily under the designation of "science and art" chools.

The problem how to determine the curriculum of a special school for youths of fifteen or sixteen destined for the conduct of business in a merchant's or banker's office becomes, therefore, one of considerable practical importance, and a large part of this book is devoted to its solution. Prominent among the conditions of success is the practice of *oral* instruction in modern languages, and constant conversational exercise as a necessary preliminary to book work and the technicalities of grammar. "The ear often remains untaught even after the eye has grasped all there is to know of the grammar and construction of the language." In this connection the particulars given in the book respecting the travelling scholarships of Germany and Switzerland and Belgium, and other devices for acquiring practical familiarity with the spoken language, are helpful and suggestive. The authors very properly insist on the need of a thorough acquaintance with arithmetic; but they evidently attach more importance to varied practical exercise in the art of computing, and to its application to tariffs, freightage, exchanges and other technicalities which have a visible and immediate relation to markets and counting houses, than to arithmetic as a science. The best experience on this subject, however, points to the conclusion that the learner whose attention has been directed, by means of demonstrative lessons and by some instruction in algebra, to the theory which underlies the truths of arithmetic, is in a better position to apply his knowledge in after life to business problems, whatever form they may happen to take, than he who has prematurely loaded his memory with rules and terminology relating to the details of commerce. On the subject of geography, and the effect of climate and physical conditions upon the nature and value of products, some hints are given which are well calculated to suggest to teachers more practical and interesting methods of teaching than are generally adopted in geographical lessons. The authors are right also in attaching importance to some knowledge of political economy, a subject which receives a good deal of attention in the higher commercial departments attached to the *Realschulen* of Germany. It is hardly recognised in England yet that the elements of social economics and the general conditions of industrial prosperity, the relative values of different kinds of labour, the laws which govern the rate of wages and the interest of money are subjects which can be made very intelligible and attractive to young people towards the end of their school life, and before entering into the arena of business competition. Such knowledge is not without a moral value of its own, for it reveals to the learner the need of industry, forethought, punctuality, self-restraint and thrift, and goes far to show the relation of conduct to real success in life.

The particulars given in this book respecting the College of Commerce and Politics in the University of Chicago, the Higher Institute of Commerce at Antwerp, the School of Commerce in Neuchâtel, and the commercial courses of University grade at Magdeburg Frankfort, Berlin, Dusseldorf and Leipsic, may serve to remind us of the fact that in England scientific preparation for the profession of commerce has hitherto not been recognised as a legitimate part of University work. A step has indeed been recently taken, thanks to the boundless munificence of Mr. Passmore Edwards, towards the permanent establishment of a School of Economics and of Commerce in connection with the renovated University of London. Much may be hoped from this novel and interesting experiment. *Inter alia* it may have a great effect on schools and other institutions of a lower rank, whose pupils will hereafter graduate in the new Faculty of Commerce. It is one of the offices of a University to show how the higher professions may be aided and quickened, and by setting up a lofty standard of thorough and scientific preparation, to reveal the true relations of academic culture to the qualities which make successful merchants and captains of industry. If this object be attained at the apex of our educational structure in the Universities, the aims of those who control the lower agencies, such as commercial classes in Polytechnics and in secondary schools will become clearer, and the practice of those institutions will be freed from the narrowing influences which have been long associated with the more ignoble type of "commercial academy."

The modest design described in the preface and the title of this volume has, on the whole, been usefully and sensibly attained. Those readers who seek the latest information respecting the ideals of "commercial education" which prevail in America and on the European continent, and the machinery which exists for translating those ideals into practice, will find much to interest them. But those who are trying to make up their minds on the larger problems—What is the place which special knowledge of commercial subjects ought to hold in a scheme of liberal education? How are we to secure that the higher claims of manhood and intelligence shall not be sacrificed prematurely to the lower claims of money-making and "getting on"? and What other studies ought to be pursued concurrently with business training in order to maintain the right balance of character in the future citizen?—must look elsewhere for the help and guidance they desire.

THE BIRDS OF ICELAND.

Manual of the Birds of Iceland. By Henry H. Slater, M.A., F.Z.S. Pp. xxiii + 150; 3 plates and map. (Edinburgh: David Douglas, 1901.) Price 5*s.* net.

MR. Slater has very acceptably filled the want, which many of us have felt, of a handy manual on the birds of Iceland. Much information on the subject is to be found scattered among Icelandic, Danish, German, Latin and English books and periodicals (the bibliography in the present volume comprises more than sixty titles), and this has now been revised and condensed in a compendious, handy form. Added to this we have now the personal observations made by the author in the occasional visits he has paid to Iceland during the last fifteen years, making altogether the most (indeed the only) complete account of the birds of this out-of-the-way corner of Europe which we possess. Without ministering to the insatiable appetite of the egg collector by disclosing the exact breeding localities of the rarer birds, the author has striven to make his manual useful to the many Englishmen who go to Iceland every year for various purposes, and who may take some interest in its birds. Besides reviewing and recommending certain earlier accounts of the ornithology, he names a good guide-book and some maps; and he gives a brief but useful description of the plumage of most of the birds (except those that are common and universally known) and also of the nests and eggs. In the introduction, too, we find some very necessary remarks on the English habit of misspelling and mispronouncing Icelandic words. And following this, and a statement upon the law as to the close-time for birds in Iceland, are three pages of most instructive suggestions on the right pronunciation of the language. All the species on the Icelandic list (one hundred and three, exclusive of eleven the occurrence of which is doubtful, and one, the great auk, which is extinct) are clearly and accurately dealt with in the body of the work; and the native names of the birds, if any, are indicated. The volume is in truth a manual, and its handy size will enable any traveller, however light his baggage, to find room for it.

From its geographical position, far north, and on the extreme west of the Palæarctic region, the avifauna is, as might be expected, a somewhat poor and limited one. It is made up, roughly speaking, of thirty-seven resident species, twenty-seven summer migrants (making sixty-four breeding species, three of which are a little doubtful), twenty-one occasional visitors and eighteen rare stragglers. The resident land-birds number only seven, and the land-birds which come to Iceland in summer to breed only five. The fauna is poorest in Passeres, of which we in England have so many; in Iceland there are only nineteen, eleven of which are only occasional or rare visitors. There are seven birds of prey on the list, two of which are resident and one a summer migrant. The three owls are only visitors. There is one game-bird, viz. the rock ptarmigan. We should add that the author is not responsible for this attempt to analyse the Icelandic avifauna. The great auk at one time resorted to Iceland. Nowadays, perhaps, the northern wren, the great northern diver (a western species, breeding nowhere else in Europe, unless it does so in the north of Scotland), and the Iceland falcon, famous among falconers in old days, are the most interesting birds to be found there. With regard to the wren (which is protected all the year round by law) the author remarks that there can be no reasonable doubt that the great increase of domestic cats in Iceland of recent years is leading very rapidly to its extermination—a fact which bird-protectionists in England would do well to lay to heart. But Iceland is very rich in ducks and geese, sixteen—possibly eighteen – species breeding there. Perhaps from a zoo-geographical point of view Iceland is most interesting as forming a link between the Palæarctic and Nearctic regions. Indeed, the number of birds which are common to the Icelandic and Greenlandic avifaunas, either as regular inhabitants or wanderers, is surprising. The manual, illustrated by three interesting plates and a map, is one of the most acceptable books which have fallen into the hands of the ornithologist for a long time.

OUR BOOK SHELF.

Blütengeheimnisse: Eine Blütenbiologie in Einzelbildern. By Georg Worgitzky. Mit 25 Abbildungen im Text. Buchschmuck von J. V. Cissarz. Pp. x + 134. (Leipzig: Teubner, 1901). Price 3 marks.

THIS title recalls that which was used in 1793 by Christian Konrad Sprengel, and to him the author traces the beginning of the bionomical study of flowers and their fertilisation which forms the subject of the little book before us. Since Sprengel laid the foundations there have been many workers, notably Darwin and Hermann Müller, and many new facts have come to light, while others observed more than a century ago have been rendered more precise. Therefore the author has been led to supply an introduction to the study, simple enough for beginners, and at the same time up-to-date. His method has been to select two dozen common plants, in flower at various times of year from February to October, and to tell the story of their pollination.

Poppy, wild rose, lime, buttercup, forget-me-not, meadow cranesbill and wild radish form the first and simplest group; white dead-nettle, iris, violet, campanula, figwort, cowslip and pink introduce the student to slight complications; broom, spotted orchis, wild carrot, centaury and ling illustrate special adaptations; while flowers pollinated by the wind are exemplified by ribwort, rye, hazel, willow and pine tree. The second part of the book is occupied with a simple discussion of the parts of the flower, the modes of attracting useful visitors, and warding off those that are injurious, dichogamy, self-pollination and kindred topics.

We cannot say that there is either novelty or individuality in Worgitzky's book, but it is clear, accurate, without waste of words, and objective from first to last. The pages are adorned with decorative devices and there are twenty-five simple figures with the amount of enlargement always indicated. Our only grumble is that the author keeps so consistently to the *rôle* of the descriptive naturalist and does not discuss the numerous evolutionist problems which his facts inevitably raise in the inquiring mind. Of course this must have been done deliberately, but we think that the author should have given clearer indication that beyond the floral secrets which he lays bare there lie others not less fascinating, though more mysterious.

The Lepidoptera of the British Islands: a Descriptive Account of the Families, Genera and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits and Localities. By Charles G. Barrett, F.E.S. Vol. vii. Heterocera, Geometrina. Pp. 335. (London: Lovell Reeve and Co., Ltd., 1901.) Price 12*s*. net; large paper, with coloured plates, 63*s*. net.

AMONG the numerous smaller publications on British Lepidoptera, most of which are useful and interesting in their own way, Mr. Barrett's great work pursues the even tenor of its course, a Triton among minnows, and likely to hold its place as the standard work for the student of British Lepidoptera for many a long day.

The present volume includes the full life-history, as far as is known, of eighty-four species of Geometridæ considered as British, two or three more being incidentally mentioned as European species probably admitted into our British lists by error. These are placed in the three families Boarmidæ, Geometridæ and Acidalidæ, the genus Ephyra being included in the latter family (Ephyra and Hyria being the only genera of the last family included in this volume), while the portion of the Boarmidæ which falls into it includes species formerly classed in Guenée's families Fidonidæ, Ennomidæ, Amphidasidæ, Boarmidæ, Hibernidæ, Zerenidæ and Ligidæ. Guenée's subdivision of the Geometridæ was never accepted in Germany, where the number of families was reduced by many authors to two; and in 1895 Sir George F. Hampson, in vol. iii. of his "Moths of British India," cut down Guenée's numerous families to six, in which he has been followed by many writers since, including Staudinger and Rebel in the catalogue just published. We believe ourselves that, though Guenée may have established more subdivisions than necessary, yet that the modern reaction has gone too far, and that some of his families which have been now abandoned will subsequently be reinstated.

Of the general execution of Mr. Barrett's work we have spoken fully in our notices of previous volumes. The present volume contains detailed notices of several species of considerable interest, such as *Nyssia zonaria*, *Abraxas grossulariata* and *Hibernia defoliata*. Mr. Barrett does not seem to be aware that *Nyssia zonaria*, an insect of our dry coast sand-hills, is said to be found in marshy localities instead, in France. W. F. K.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Testing of some Ballistic Experiments.

WHEN the Council of Military Education directed my attention to the science of ballistics in 1864, I came to the conclusion that a thoroughly good chronograph would solve all practical difficulties. The newly-invented instrument was first tried in 1865 with ten screens 120 feet apart, by the use of a 12-pr. Armstrong B.L. gun, when eleven satisfactory rounds were obtained. (Report (84/B/1941), and (*Proc.* of the R.A. Inst., 1866.) Afterwards Government decided to have systematic experiments made to determine the resistance of the air to ogival headed projectiles (1·5*d*) fired from 3, 5, 7 and 9-inch M.L. guns, which were carried out in 1867–68 for velocities 900 to 1700 f.s. The results then obtained are still in use.

In 1871–72 I published general tables, S_v connecting range and velocity, and T_v connecting time and velocity. These tables were adapted to calculate the motion of a projectile when moving in the direction of its axis and acted upon only by the resistance of the air. These tables have now come into general use.

In order to test my first trial experiment of 1865, I will now calculate, by the use of these general tables, S_v and T_v, founded on the results of experiments 1867–68, the time in which the experimental projectile would travel from the first to each succeeding screen, for comparison with the average times determined by the trial experiments, and published 1865–66. Here $w = 11{\cdot}5625$ lbs.; $d = 3$ inches; $d^2/w = 0{\cdot}77838$; $w/d^2 = 1{\cdot}28472$; $S_v = S_v - sd^2/w = 41261{\cdot}883 - n93{\cdot}406$, where n is to be taken 0, 1, 2 . . . 9 in succession to obtain the velocity at each screen. And $(T_v - T_v)w/d^2$ gives the time in which the velocity of the projectile falls from v to v. (Tables in "Text-book of Gunnery, 1897.")

(α)

Screen.	Exp. time 1866.	Calc. time 1901.	Difference.
	"	"	"
1	0·00000	0·00000	0·00000
2	·10489	·10503	– ·00014
3	·21106	·21121	– ·00015
4	·31845	·31861	– ·00016
5	·42705	·42743	– ·00038
6	·53684	·53714	– ·00030
7	·64780	·64814	– ·00034
8	·75988	·76030	– ·00042
9	·87309	·87361	– ·00052
10	·98831	·98756	+ ·00075

Further, the mean velocity of the projectile, at every 10 feet from the first screen, was calculated from the results of the first trial experiment, and published in the *Proceedings*, 1866. I will now *calculate* the velocity of the projectile at every 100 feet for comparison. Here $S_v = S_v - sd^2/w = 41254{\cdot}1 - n7{\cdot}7838$, where n must be taken in succession 0, 1, 2, &c., to find the velocity at 130, 140, 150, &c., feet from the gun. The following results have been thus obtained:—

(β)

Dist. from gun.	Proceedings, &c. 1866.	Calculated 1901.	Difference.
Feet.	f.s.	f.s.	f.s.
130	1149·4	1149·0	+0·4
140	1148·2	1147·9	+0·3
150	1147·1	1146·7	+0·4
200	1141·3	1141·2	+0·1
300	1130·2	1130·2	0·0
400	1119·4	1119·4	0·0
500	1108·8	1108·9	–0·1
600	1098·7	1098·8	–0·1
700	1089·0	1088·9	+0·1
800	1079·6	1079·5	+0·1
900	1070·5	1070·5	0 0
1000	1061·7	1061·9	–0·2

These two examples (α) and (β), comparing the results of experiment published in 1865–66, and of calculation in 1901, conclusively show the remarkable accuracy

(1) of the trial experiment of 1865,
(2) of the systematic experiments 1867–68,
and (3) of the general tables, 1871, used to connect (1) and (2).

This chronograph was used in all subsequent experiments.

The experiments of 1867–68 were continued by the use of a new 6-inch B.L. Armstrong gun in 1878–79 (Report 84/B/2853), and further with a new 8-inch Armstrong gun in 1880 (Report 84/B/2909). The coefficients of resistance to ogival headed shot (1·5*d*) for velocities 100 to 2800 f.s. were thus determined. At an early period it was decided to employ J. Bernoulli's method of calculating trajectories. As opportunity offered, the calculation of auxiliary tables (X), (Y), (T) and (V) was proceeded with, of which 97 pages were published in 1873, and 48 pages in 1881, for the cubic law of resistance. And 70 pages were published in 1890 for the Newtonian law. The ogival form of head (1·5*d*) chosen by Government was a very good form for standard experiments, as such projectiles were steadier than more acutely pointed projectiles, and the results obtained were easily adapted to other useful forms by using $\kappa d^2/w$ instead of d^2/w. Thus ogivals (2*d*) were found to encounter a resistance 3 per cent. less than the ogivals (1·5*d*), which gives $\kappa = 0{\cdot}97$, and I do not remember having had to use any smaller value of κ. I consider that a reduction of 5 per cent., or $\kappa = 0{\cdot}95$, would be the least value of κ for projectiles of any practical use.

The only difficulty in experimenting was when the velocity was *low*, for then the trajectories were much curved. But the results obtained were tested by the calculation of 32 rounds of English 6·3-inch Howitzer, and 82 rounds of German 15 cm. Kurze Kanone for velocities 330 to 750 f.s. and found satisfactory. (Final Report, pp. 45–47.) The results for *high* velocities were tested by calculating, by the use of the general tables ($\kappa = 1$) the times over given ranges of 1000, 2000, &c., yards, where the elevation of the gun was low, using horizontal muzzle velocities for the 4-inch B.L. 1884; the 6-inch Q.F. 1891; and 1893; the 9·2-inch B.L. 1898; and the 12-inch B.L. gun; for velocities 1000 to 2600 f.s. My coefficients of resistance appeared to be slightly too low. (Second Supplement, p. 15.)

When trajectories are calculated as tests of coefficients, it is necessary that both the calculated range and time of flight agree with experiment. But when an elongated shot was fired with a high velocity, it was found that both the calculated ranges and times of flight were shorter than those given by experiment. If then the resistance was reduced so as to give the desired range, the calculated time of flight was found to be too short. Hence it was clear that the error could not be corrected by any change of coefficient of resistance.

When elongated shot came into use, it was well understood that the projectile would be deflected upwards by the resistance of the air, so as to increase the elevation for which the gun was laid. This was named "kite-like action" in England, and Didion remarked that there would be a considerable deviation of the projectile "tant dans le *plan vertical*, que dans le plan horizontal" (*Traité*, xiii. 1860). Suppose now that the range r and the time of flight t, for an elevation α, have been carefully calculated. Then from the range table of the same gun, corresponding to same range r, find t' the time of flight, and α' the elevation. Then if $t=t'$ the coefficients of resistance giving the required time and range, are correct, and $\alpha-\alpha'$ is due to kite-like action. Thus, using the range table of the 4-inch B.L. gun: $v=1900$ f.s.; $w=25$ lbs.; $\alpha=12°$; and $\kappa=0·97$.

(γ)

	Range.	Time of flight.	Elevation.
Calculation ...	$r=5666$ yards	$t=17''·008$	$\alpha=12°\ 0'$
R. Table ..	$r=5666$,,	$t'=16''·964$	$\alpha'=11°\ 26'$
Difference ...	0	$t-t'=0''·044$	$\alpha-\alpha'=0°\ 34'$

Here for a range of over three miles, the calculated and observed times of flight, from point to point, differ by only $0''·044$, a negligible quantity. The resistance of the air must therefore have increased the elevation, for which the gun was laid, by $\alpha-\alpha'=34'$, due to jump and kite-like action, for an elevation of the gun of 11° 26′. The whole range table of the 4-inch B.L. gun was thus treated in 1892 (NATURE, No. 1190). These calculations have recently been repeated for elevations 7° to 20°, and published in my Second Supplement, where all the leading steps in the calculation of the ranges, &c., have been given. It was then found that when an elevation of 7° is given to the gun, 21′ is added to the elevation by kite-like action, so that 7° + 21′ must be used for the elevation when it is required to *calculate* the range and time of flight for an elevation 7° of the gun. The elevation of the gun is given in degrees below, and the addition thereto made by kite-like action and jump is given in minutes, 7° + 21′, 8° + 23′, 9° + 26′, 10° + 29′, 11° + 33′, 12° + 38′, 13° + 45′, 14° + 53′, 15° + 63′, 16° + 74′, 17° + 86′, 18° + 98′.

From the results of calculations of range and time above referred to, I have deduced the following table:—

Range.	Time of Flight.			Elevation.		
Yards.	R.T.	Calculated.	Diff.	R.T.	Calculated.	Diff.
	"	"	"	° ′	° ′	′
4000	10·49	10·35	−0·14	6 21	6 32	+11
5000	14·30	14·19	−0·11	90 12	9 37	+25
6000	18 40	18·51	+0·11	12 36	13 18	+42
7000	23·50	23·59	+0·09	16 32	17 59	+87

showing clearly that both *range* and *time* of flight—given by *experiment* and *calculation*—agree, when a proper allowance is made for jump and kite-like action.

From the fair application of all these tests, it appears that calculated and experimental ranges and times of flight agree perfectly well for all practical purposes. Hence the laws of resistance determined by me—the general tables published by me—and the adaptation by me of J. Bernoulli's method of calculating trajectories are all quite satisfactory. But care will be required not to make my methods responsible, in any way, for the disturbing effects of jump or of kite-like action. Consequently range tables cannot at present be prepared by calculation alone, but when obtained by experiment, they may be tested at any point by the method (γ) already explained.

This chronograph might be used with great advantage to test the shooting qualities of all big guns. For this purpose the elongated projectiles should be provided with heads of similar forms. The charges used should be such as would give the velocity v, for which the gun is to be tested, near the middle screen. Fire each projectile through the equidistant screens till n satisfactory rounds have been obtained. Calculate K_v', K_v'', &c., for each of these rounds. Then the approximate value of $K_v=\frac{1}{n}(K_v'+K_v''+\&c.)$, and the mean error will be an indication of the steadiness imparted by the gun to its projectile, and so on for any number of guns. The shooting qualities of any guns could be compared for the velocity v, by simply comparing the numerical values of K_v given by each gun—the lower the numerical value of K_v the better the shooting. Target practice might be carried on simultaneously with these screen experiments. The best of the guns taken in South Africa should be brought home and tested in the manner above recommended.

August 1901. F. BASHFORTH.

Horn-feeding Larvæ.

So far back as June, 1898, you published in NATURE a short article from my pen dealing with "Horn-feeding Larvæ"; it opened up the question as to whether the larvæ of the insect *Tinea vastella*, Zell. = *gigantella*, Stn. = *lucidella*, WKr., fed on the horns of living animals. I mentioned at the time that Dr. Fitzgibbon, in 1856, brought home from the Gambia two pairs of horns, one belonging to *Kolus ellipsiprymnus* and the other to *Oreas canna*, which he had purchased from the natives; the horns were perforated by grubs enclosed in cases which projected abundantly from the surface of the horns, the blood at the base of the horns not having thoroughly dried up on them when brought to market.

Dr. Henry Strachan, of Lagos, wrote a letter, dated July 22, 1898, which appeared in NATURE, and in that letter he stated that the living horns were attacked and infested with the larvæ, as cocoons and pupæ had been extracted from such horns within an hour of the killing of the animals owning them. This he states on the unimpeachable authority of an officer who made the observation.

During 1899, 1900, and until July of this year, I have travelled very considerably in West Africa, having spent these years in Northern and Southern Nigeria, as well as Ashanti and the hinterland of the Gold Coast; I have made close observation of many species of horned animals, and have spent many days with native big game hunters. I have seen many cases in which the horns of dead animals have been infested with the larvæ of the *Tineidae*, but have never met with it in those of living animals. The natives with whom I have been associated, who are keen hunters and extremely keen observers, assure me they have never seen any protuberances containing grubs on the horns of living animals. During our campaign in Ashanti, I questioned officers who came with troops from all parts of the West Coast as well as the East Coast of Africa; also some from Uganda and the Lakes: they all unhesitatingly say that they have never seen cocoons on living animals, although well acquainted with them on the horns of dead animals. Dr. Fitzgibbon's statement stood alone until Dr. Strachan's letter appeared. I venture to suggest that the point still remains *sub judice*. W. J. HUME MCCORQUODALE.

August 30.

NEW GARDEN PLANTS: A STUDY IN EVOLUTION.

THE appellation "new garden-plants" is rather puzzling to those who are neither botanists nor gardeners, and, indeed, it is used with somewhat different significations by both these classes of experts. Considering that not the least of the many services rendered by the Royal Gardens, Kew, is the annual publication, as an appendix to the *Kew Bulletin*, of a list of "new garden plants," some explanation of what is meant by this designation may not be without interest. Let us take an illustration. The maidenhair tree, *Ginkgo biloba*, was in reality introduced into our gardens in 1750 or thereabouts. But let us suppose for our present purpose that it was introduced only in this year of grace 1901. Would it in that case have any right to be considered a "new plant"? If we look on it as the direct lineal descendant of a tree that grew in Greenland in Miocene times and had its ancestry still further back in the Oolitic period, we could hardly consider it as "new." The only novelty about it would be its introduction into gardens. Similarly, the Welwitschia, now in cultivation at Kew and elsewhere, was, in garden parlance, a new plant. It was new to Welwitsch when he discovered it in the deserts of Mossamedes in South-West Africa, but nobody looking at the uncouth "monster" would deem it new. Rather would he think of it, as he has a clear right to do in the case of the Ginkgo, as a survival from a prehistoric past. Welwitschia has not, so far as we know, been discovered in a fossil state, but if our Antarctic "discoverers" should light upon its traces near the South Pole, no one would be greatly surprised.

In such cases as these, then, it is the introduction into gardens as cultivated plants that constitutes the novelty. And so it is with the hosts of species of orchids, palms, ferns and other plants with which the zeal of botanists or the enterprise of collectors enriches our gardens. Many of these are absolutely new—new to science, that is, as well as new in gardens. Others are novelties so far as the garden is concerned, but have previously been known to, and duly recorded by, the botanist.

But there is still another category of "new garden plants," and one of such vast interest to the student of evolution that we cannot but express our astonishment that so fertile a field of research has hitherto attracted so few labourers. We allude to new plants actually created in gardens by the skill of the gardener. The materials, no doubt, exist in nature, the gardener does but rearrange them, as the milliner forms "ravishing creations" by tasteful intermixture of tulle and ribbon. But the gardener does more than the milliner. He not only effects kaleidoscopic changes of the same materials, but he sets in operation previously pent-up forces—forces which are made manifest in the phenomena of variation, adaptation and progressive evolution. The modern gardener, by means of incessant vigilance and adjustment of the conditions of environment, so far as he is able to do so, *cultivates* the plants committed to his charge so as to obtain the most healthy foliage, the finest flowers or the most luscious fruit according to his particular requirements. But cultivation is not everything. It improves the old, but it does not create the new. Selection, again, by which the gardener profits much, does not in all cases result in absolute novelty, but only in enhanced quality, a lessened amount of variability and a greater degree of fixity or constancy. A seedsman's "stock" of broccoli, or whatever it may be, is carefully "selected" by the choice and retention of what is required and by the rejection or elimination of what is not desired. The "rogues," that is the plants which do not come up to the high standard of perfection, are ruthlessly destroyed. By these procedures, carried on year by year, the stock at length becomes almost absolutely pure, and, what is more, it is kept so because the tendency to vary has become quiescent. Alter the conditions, exercise less vigilance, variation will again set in and the stock become correspondingly deteriorated. Cultivation, selection and elimination tend to preserve the old rather than to create the new.

Novelty in garden plants, apart from the direct importation of new species from foreign countries, is secured in various ways, such as the conservation or selection of variations which originate naturally. By repeated selection and elimination the desired variation is, as we have just said, finally "fixed." It becomes constant and capable of reproduction by seed. Another method of obtaining novelties is by the observation, retention and propagation of bud-variations or sports. A third and most effectual means is secured by the practice of cross-breeding.

Variation in some degree is almost universal; no two leaves on the same branch are alike, the peas in a pod really contradict the meaning of the proverbial adage, for, instead of being strictly alike, they are more or less different. But the discontinuous variation, the "sport" proper, as it is understood in gardens, is the representative of a more pronounced degree of variation—one that occurs suddenly, or at least its earlier manifestations are so inconspicuous as to be overlooked. It appears simultaneously in widely separated areas. It is mysterious in origin as it is striking in appearance. No doubt in many cases this sporting is a reversion to some ancestral condition, or is due to a separation of previously amalgamated characteristics, but what brings about the separation is a mystery. In any case, the gardener has little or no control over the phenomena of sporting; he does but avail himself of what nature provides him without any effort of his own.

It is a very different thing with cross-breeding. The larger number of "new garden-plants" at the present day are due to intentional cross-pollination or fertilisation. All degrees of this process occur from the union of male and female elements from individuals that present the least degree of distinctiveness up to the combination of the sexual elements in plants so wide apart as to be, for practical purposes at any rate, placed in distinct genera, and in one recorded case in a distinct order. Bigeneric hybrids have been recorded between *Philesia* and *Lapageria* (=Philageria × Mast.), between *Urceolina* and *Eucharis* (=Urceocharis × Mast.), between *Rochea falcata* and *Crassula coccinea* (= Kalorochea × Veitch), *Libonia* and *Sericographis* (= Sericobonia ×), between *Montbretia* and *Tritonia*, between numerous genera of Gesneraceæ, between *Scilla* and *Chionodoxa* (=Chionoscilla ×). Amongst orchids no fewer than 150 bigeneric crosses are recorded (Hurst, in *Journal* of the Royal Horticultural Society, 1900, vol. xxiv. p. 102).

In 1849 Donckelaar, the younger, the curator of the Botanic Garden at Ghent, raised a hybrid out of *Gesnera discolor* by pollen of a Gloxinia. This was called *Gesnera Donckelaariana* by Lemaire in the Jardin Fleuriste (1854), t. iv. p. 382. The good faith of the gardener was needlessly and unjustly impugned, and the hybrid nature of the plant was doubted by Decaisne, as was not unnatural at that time. But now that, as we shall presently see, the gardener has succeeded in actually producing by art the same form that exists in nature, there is no more occasion for scepticism.

Decaisne suggested that Donckelaar's plant was no hybrid, but a new species accidentally introduced with other species of Gesneraceæ. This view received confirmation some years later when Messrs. Veitch received from Colombia a plant which on flowering presented all the characteristics of *Gesnera Donckelaariana*. This plant was figured and described as a species by Sir Joseph Hooker in the *Botanical Magazine*, t. 5070 (1858). Several years afterwards (in 1894) Messrs. Veitch produced a hybrid between *Gesnera pyramidalis* crossed with pollen of Gloxinia "Radiance." This received the name of "Gloxinera ×," and is a sufficient proof that bigeneric hybrids may occur in Gesneraceæ. The Gloxinera was figured and described by Mr. J. Weathers in the *Gardeners' Chronicle* (February 2, 1895), and formed the subject of an interesting note from Count de Kerchove de Denterghem in a subsequent number (February 9, 1895, p. 175).

Many other bigeneric hybrids are recorded among the Gesneraceæ, but, until botanists have agreed as to the limitations and nomenclature of genera in this order (which they are far from having done at present), we must suspend our judgment as to the precise status of the numerous hybrids that are alleged to have been raised. For an account of them up to the time of publication, the reader may be referred to Mr. Burbidge's excellent work on "Cultivated Plants, their Propagation and Improvement" (1877), and to Dr. Focke's "Die Pflanzen Mischlinge" (1881), p. 326 *et seq.*

A still further degree of hybridisation is recorded in Maund's "Botanic Garden" (v. p. 468), where a cross from *Digitalis ambigua* (Scrophulariaceæ) by pollen of *Sinningia speciosa* (Gesneraceæ) is described. This, then, was a biordinal hybrid.

Fertile hybrids, the existence of which was once denied, are now too numerous to admit of further doubt. Mr. Hurst, *l.c.*, cites the occurrence of such plants in ninety distinct genera and only four in which the hybrids are quite infertile. Ninety per cent. of some forms of tuberous Begonias come true from seed, as is recorded in Mr. Lynch's excellent paper on the evolution of plants in the *Journal* of the Royal Horticultural Society (vol. xxv. 1900, p. 24). In that paper numerous illustrations are adduced to show that some garden hybrids, perhaps we might say a large proportion, "come true from seed," that is, the parental characters are reproduced in the progeny as markedly as in the case of any so-called species. Bigeneric hybrids are sometimes equally fertile. For instance, there are two Iridaceous genera, Montbretia and Tritonia, so distinct one from the other that they have always been considered as separate genera. Now the plant called *Montbretia crocosmiaeflora* × by Lemoine was raised by that eminent French gardener between *Tritonia aurea*, which furnished the pollen, and *Montbretia Pottsii* as the female parent. This is what M. E. Lemoine says in the volume to which we have just referred (p. 128):—

"It is generally admitted by all that hybrids are, as a rule, either absolutely barren or at most produce descendants as lacking in number as they are also in vigour and in reproductive qualities. Now *Montbretia crocosmiaeflora* × is a hybrid, and by no means an ordinary hybrid, for it is one of the very small group of bigeneric hybrids, its two parents ranking as species of different genera, and yet it has given birth to a long line of vigorous and fertile plants." This hybrid produces seed naturally, but as the progeny is almost identical with the parent form there is no particular object in the gardener raising such seedlings. But when the flowers of this hybrid are pollinated, by pollen taken from either of the original plants, then modification sets in and these modifications have become fixed (see p. 129).

Chionoscilla ×. The hybrid genus between Chionodoxa and Scilla, which occurs spontaneously when the two plants are grown together, is reported by Hurst to have produced fertile seeds.

Whether the facts that some of the so-called genera not only interbreed but "come true from seed" are to be taken as proofs against their autonomy as separate genera or not is a point of the highest interest, to which we can only allude, but which we cannot here discuss. We must be permitted for our present purpose to set aside theoretical considerations and to look on both species and genera as convenient subdivisions necessitated by the requirements of classification, but which, though probably so, are not yet proven to be phylogenetically "natural." All that we are concerned here to assert is that the gardener has succeeded in producing forms as distinct one from another as, often far more so than, those which we call species, and even genera, and which physiologically as well as morphologically "behave" in the same way that species do.

Tuberous Begonias furnish a case in point. They are no older than, scarcely so old as, the middle of the last century. Their history is perfectly well known. They have grown, as it were, under our very eyes. Were it not so there is no botanist who, seeing them for the first time, but would call them new species and think himself very fortunate in getting new species with such definite and easily recognisable marks of distinction. A distinguished French botanist, the late M. Fournier, even constituted a new genus, Lemoinea, to receive some of these widely divergent forms.

But, some will say, these creations of the gardener's skill are not permanent; alter the conditions and they will disappear. Moreover, they can only be propagated by division and not by seed. Were these objections universally true they would, of course, be fatal to our contention. But they are not universally true, and those that are true are just as applicable to natural species. Some at least, as we have seen, have a high degree of permanence, and many are capable of reproduction from seed.

It must not be supposed that these hybrid productions are all of artificial origin. So far back as 1852, Weddell enumerated, in the *Annales des Sciences Naturelles*, numerous natural bigeneric hybrids, and, of course, hybrids between species are now known to occur frequently among wild plants. But what is very interesting in this connection is the fact that gardeners have, over and over again, demonstrated the hybrid nature of certain wild plants by actually producing them artificially. The younger Reichenbach, from his great knowledge and experience, asserted that several orchids examined by him were of hybrid origin. He arrived at his conclusions solely from the observation of morphological characters. But Veitch and many others have since actually created in their orchid houses, by means of cross fertilising the two species, the same form that occurs in nature. They have proved by demonstration what Reichenbach merely conjectured from appearances. An enumeration of these orchid hybrids that have been produced in gardens is given by Mr. Rolfe in vol. xxiv. of the *Journal* of the Royal Horticultural Society, p. 188. Years before Reichenbach, Dean Herbert came to a similar conclusion as to the hybrid nature of certain Pyrenean narcissi, and he too proved the accuracy of his opinion by producing the hybrid form by artificial means. In our own times, Engelheart is doing the same sort of work and arriving at the same conclusions.

In the last class of cases, the gardeners have, as we have said, succeeded in reproducing the identical form that occurs in nature, and that form, of course, cannot be considered in any sense as a *new* garden-plant. But in the other cases mentioned, such as the Begonias, the Streptocarpus, the Clematis, &c., forms have been produced which have not, and could not have, any counterpart in nature. Some of the Andine Begonias very possibly hybridise naturally because they grow in proximity, or at no very great distance from each other. But what are we to say to the new "race" or "species," as we might term it, produced in gardens by fertilising the descendants of these South American Begonias with one discovered in Socotra by Prof. Bayley Balfour? It is hard to conceive of the possibility of a natural hybrid in this case, but, as artificially produced by the gardener, it is one of the greatest ornaments of our hot-houses and much more distinct from other "species" than most of the South American forms among themselves. It is true that in this case, up to this time, the flowers have been mostly sterile, but there are not wanting indications that the sterility may be naturally replaced by fertility, whilst it is certain that the gardener will discover the means to counteract the present nearly barren condition.

It would be easy to multiply instances wherein the gardener has produced new forms morphologically, and in some cases physiologically, worthy of specific or even of generic rank, but it is unnecessary to cite more, as the fact admits of no dispute. We have alluded to them here for the sake of illustrating one category of "new garden plants."

A point of much practical importance arises with reference to the names that should be given to these garden productions. The Kew list to which we have referred takes the names as they are published in the gardening journals, which in their turn copy them from the labels or the catalogues of the horticulturists. The journals are duly cited in the Kew list, but in no case is the author's name mentioned.

In the majority of instances this is the only course that could be advantageously followed, for the names are generally given without adequate research and with no reference to system. They are, in fact, the outcome of the nomenclator's fancy solely. But in many cases the plant is authoritatively described in the gardening periodicals, and when that is the case the customary citation might with advantage be made in the Kew list.

One most objectionable practice the gardeners have, and that is of imitating the names given by botanists *secundum artem*. In the eyes of the scholar, botanical nomenclature is mostly barbarous, but garden nomenclature is too often ludicrous. It is more than that, it is misleading. A botanist ignorant of the history of a garden plant and finding it provided with a Latin generic and specific name would naturally suppose that he had to deal with a species properly described and recorded, and would waste his time and patience in fruitless search unless by good fortune he lighted on the Kew *Bulletin*.

But if some sort of provisional name could be given to plants of garden origin or to plants of unknown status, such name to be so framed as not to give rise to misapprehension, horticulture would not suffer and science—at least indirectly—would be the gainer.

The Royal Horticultural Society has, at various times, endeavoured to grapple with this evil, and has even formulated a code of rules to be followed by the horticulturists when introducing "new" plants to the notice of the Society or the public. The rules are excellent, but they are far more frequently honoured in the breach than in the observance, and the Society seems powerless to enforce its own precepts even in its own records. The alliance of old custom with new developments, however anomalous, seems likely to persist in the future as it has done in the past. The Kew publications to which we have referred are invaluable to the student by lessening the difficulties of research and neutralising the anomalies of which mention has been made.

THE PHOTOGRAPHIC CHART OF THE HEAVENS.[1]

IT is to be regretted that a whole year has been allowed to intervene between the meeting of the International Committee charged with the construction of the photographic chart of the heavens and the official publication of the proceedings of the members, since the interest that would otherwise attach to the utterances of so many expert astronomers in conference assembled is materially lessened by the delay. Doubtless the collection of proofs from sources so scattered and so distant demands a long time, but the most careful and praiseworthy desire to secure accuracy might have been satisfied with a shorter period. Two very evident drawbacks result from this method of treatment. Not only have more or less complete statements appeared in various scientific journals, but the reports on the amount of progress effected by the various participants in the scheme refer to a twelvemonth since and are already ancient history.

But, on the other hand, it is abundantly evident that these meetings, held from time to time, perform a very useful work wherever widespread cooperation is necessary. They not only afford evidence of the earnestness of purpose and determination to successfully prosecute the scheme, that originated under the auspices of the late Admiral Mouchez, but they supply the means of most readily combining the activities of many observatories to secure a common aim. The readiness with which so many astronomers acceded to the request to undertake the observations of Eros, and the adoption of a uniform plan of wide-reaching extent, could scarcely have been effected in the time at disposal without personal intercourse and mutual encouragement. It is true that the observations have all been made and much of the reduction completed before we get the official report, but this in no way detracts from the value of the results immediately obtained, while the proceedings of the Conference will remain as a valuable historical document bearing on the progress of astronomical science.

To the general methods of observation of Eros and the success which has attended the scheme we have already referred (NATURE, vol. lxiii. p. 502), and may pass the matter aside with the reassuring reflection that the latest reports fully confirm the success that was anticipated from the earlier measures. Of the degree of completeness accomplished in the photographic surveys of the heavens it is not easy to form a very exact notion, owing to no tabular statement accompanying the report and the varied methods of description adopted by the various authorities, but the following table will exhibit fairly accurately the amount of progress reported up to the date of the meeting :—

Limits of Zone in declination	Observatory	Number of plates for catalogue	Number of plates for chart	Number of plates measured
90° to 65°	Greenwich	1106	1076	608
64 ,, 55	Rome (Vatican)	476	106	15
54 ,, 47	Catania	Complete	None	36
46 ,, 40	Helsingfors	Complete	⅓	380
39 ,, 32	Potsdam	Complete	None	(100,000 stars)
31 ,, 25	Oxford	Complete	None	736
24 ,, 18	Paris	Complete	97	650
17 ,, 11	Bordeaux	402	17	293
10 ,, 5	Toulouse	½	45	⅛
4 ,, − 2	Algiers	Complete	97	497
− 3 ,, − 9	San Fernando	Complete	596	145
− 10 ,, − 16	Tacubaya	746	None	203
− 17 ,, − 23	Santiago	(Aban	doned)	
− 24 ,, − 31	La Plata	(Aban	doned)	
− 32 ,, − 40	Rio	(Aban	doned)	
− 41 ,, − 51	Cape	Complete	Complete	126
− 52 ,, − 64	Sydney	Complete	(Greater part)	
− 65 ,, − 90	Melbourne	900	Complete	

Of the plates for the chart it is intended that there should be two series, made respectively with one exposure of an hour and three exposures of half an hour each. The word "complete" in the chart column is meant to apply to one of these series, but Sir David Gill has made considerable progress with the second series. The arrangements made for supplying the lacunæ caused by the South American observatories finding themselves unable to fulfil their engagements have already been reported (p. 335).

To judge from the number of papers presented on the determination of photographic magnitude, this subject still seems to occupy a large share of the attention of the Committee—larger, indeed, than to an outsider the subject seems to warrant. On the occasion of the meeting in 1896, the committee decided that the several observatories were at liberty to determine the photographic magnitude, either by estimation or by measurement, simply stipulating that whatever system was adopted it should be one capable of precise definition and permit

[1] "Réunion du Comité international permanent pour l'exécution de la Carte photographique du ciel, tenue à l'Observatoire de Paris en 1900." (Paris: Gauthier-Villars, 1900.)

the scales adopted to be reduced to a common system. This seems to give sufficient latitude, but, nevertheless, at the eleventh hour, no less than five different papers are presented on this vexed question of magnitude. Among other papers forming the annexe is a short but interesting note from the Astronomer Royal on the number of stars found on each of the plates devoted to photographing the Polar Cap, with a comparison with the numbers comprised in the Durchmusterung and the accurate catalogues of the Astronomische Gesellschaft. The totals are as follows :—

Number of stars measured on the plates	58,176
Number of stars to the square degree	70·0
Number of stars in Argelander's Durchmusterung	9979
Ratio of photographed stars to Bonn D.M. ...	5·83
Number of stars in A.G.C. Catalogues	4966
Ratio of photographed stars to A.G.C.	11·7

If the number of stars approximately increases as the magnitude diminishes, the ratio here given would point to the faintest stars on the plate being 1·9 mag. fainter than Argelander's faintest stars, or well covering the eleventh magnitude, originally assigned as the limit to which the catalogue should extend.

Since writing the above, M. Lœwy has published very complete details showing the approximate times of observation of the planet Eros at no less than forty-six observatories where the work has been undertaken. The energy displayed is of the most gratifying character, and the final result will no doubt demand a degree of confidence commensurate with the labour that has been bestowed on the undertaking. The work is shown to be one of gigantic magnitude, and M. Lœwy displays considerable hopefulness in suggesting that two years may see it completed. Several other papers, all devoted to securing accuracy and homogeneity in the final reductions, also appear in this brochure. We may especially call attention to a paper by the Director of the Paris Observatory on the degree of precision that the photographic measures possess, and of the success that is likely to attend the adoption of the scheme for driving the equatorial at various rates depending on the amount of geocentric motion of the planet itself. The additional matter supplied by the Paris authorities is of a highly interesting character to which we hope to do justice later, when complete details from the various authorities are published.

THE COLORADO POTATO BEETLE.

THE official announcement by the Board of Agriculture of the appearance of the Colorado potato beetle swarming in a potato field at Tilbury is a very serious matter, for we have no wish to see another insect pest added to those with which our agriculturists already have to contend. It is satisfactory to know that the Board took instant measures to cause the destruction of all the crops within the infested area ; and as the surrounding neighbourhood has since been searched in vain for any further traces of the insect, it is confidently hoped that the measures taken for its timely extirpation have proved successful.

The beetle is about half an inch long, and slightly oval in form. The wing-cases are longitudinally and alternately striped with black and yellow, and the wings are red. The grubs, which feed on a great number of other wild and cultivated plants besides the potato, are orange or reddish, with a row of black spots on each side. The oval yellow eggs are laid in clusters.

The insect was so destructive in North America some years ago that great fears were entertained of its spreading to Europe ; and at that time was passed the Destructive Insects Act, according to which every person meeting with the insect is bound, under a penalty of 10*l.*, at once to inform the police, who in their turn must notify the local authorities, who must communicate by telegraph with the Board of Agriculture.

It must be remembered that, if there is danger of an injurious insect establishing itself in a country, instant action is as necessary as in the case of a threatened epidemic. W. F. KIRBY.

PROF. BARON ADOLF ERIK VON NORDENSKJÖLD.

WHEN a man who has spent an earnest and useful life reaches the mature age of threescore years and ten, it must be a relief to those near and dear to him when his last days are not spent in suffering. The great Swedish explorer's end was in this wise. "His death," writes his nephew, Dr. Otto Nordenskjöld, "was absolutely sudden ; the same day he was working in his laboratory, occupied with great plans in his mineralogical and chemical work."

Baron Adolf Erik von Nordenskjöld was born at Helsingfors, the capital of Finland, on November 18, 1832, the third in order of seven children. His father, Nils Gustav Nordenskjöld, descended from a scientific family, and, himself an ardent naturalist, was chief of the Mining Department of Finland. Nils Gustav was a most distinguished mineralogist, and his work brought him into communication with the most eminent mineralogists and chemists of his time in France, Germany, and Britain. He travelled as far as the Urals, and on many of his journeys he was accompanied by his son, Adolf Erik von Nordenskjöld, who as a boy became an industrious collector of minerals and insects. He acquired great skill in collecting minerals and in the use of the blow-pipe, which his father handled with a masterly skill, unknown to most of the chemists of the present day. Thus, both by inheritance and by the influence of environment, Nordenskjöld had opportunities allotted only to the few, but which were taken the greatest possible advantage of. His early education was from private tuition, after which he was sent to "gymnasium" at Borgo, a connecting-link between school and university. Here he distinguished himself, as the rector expressed it, "only by absolute idleness." He was marked in his certificate "unsatisfactory" in nearly the whole of the subjects. His parents were judicious enough not to attach any importance to this well-deserved mishap. His private tutor was removed ; and with five silver roubles Nordenskjöld had to seek modest board and lodging, and got full liberty to manage his studies in his own way. "Self-respect," he says, "was thus awakened. I became exceedingly industrious, and was soon one of those then attending the gymnasium who obtained the best reports."

Nordenskjöld entered the University of Helsingfors in 1849, devoting himself chiefly to the study of chemistry, natural history, mathematics, physics, and, above all, of mineralogy and geology. He took charge of the rich mineral collection of Feugard, and made many excursions. In 1853 he accompanied his father on a mineralogical tour to Ural, when he planned an expedition to Siberia, which the Crimean War prevented him from carrying out. On his return he wrote, as his dissertation for the degree of licentiate, a paper "On the Crystalline Forms of Graphite and Chondrodite," which was discussed under the presidency of Prof. Arppe on February 28, 1855. At this time he published "A Description of Minerals found in Finland," "The Mollusca of Finland" with Dr. E. Nylander, and shorter papers in the "Acta Societatis Scientiarum Fenniæ." During this time he was appointed Curator of the Mathematico-Physical Faculty and to a post at the Mining Office with inconsiderable pay. Before he received his second quarter's salary he was removed from these offices at the instigation of the Governor-General, Count von Berg. This was done on account of some political speeches of a frolicsome nature made at a tavern in Thölö. Some of the students were rusticated for a term, and Nordenskjöld got double dismissal without further ceremony. He bore his misfortune with philosophic calmness, and betaking himself to Berlin worked in Rose's laboratory at mineral analysis.

Next year he returned to Finland, and received the Alexander stipend for a tour of study through Europe, and obtained his degree of master and doctor. At this "graduation" ceremony the Universities of Upsala and Lund had a deputation that was received in a most cordial manner, and Nordenskjöld proposed a toast "to our memories all, and to the time that has been and the time that shall come, if only it does not bring Finland's fall, a toast to the days of memory that have fled and the hope that still remains." This speech the tyrannical von Berg regarded practically as high treason. Nordenskjöld treated the whole affair with contempt, but had to leave Finland and go to Sweden. The Russian Government, moreover, deprived him of the right of ever holding office in Helsingfors University. Further persecution followed, and von Berg actually urged in the Senate, Nordenskjöld's exile for having entered foreign service without asking permission of the Russian Government. After 1862, however, when von Berg's term of office had expired, he was allowed to go to Finland whenever he pleased.

Nordenskjöld's first visit to the Polar regions was with Torell to Spitsbergen in 1858, with whom he went as geologist. At Belle Sound he found Tertiary fossil plants which formed the first of the extensive geological collections brought home by subsequent Swedish expeditions; besides these he also obtained fossils from the Carboniferous and Jurassic formations, as well as fine minerals from the limestone veins on the Norways, Cloven Cliff, &c. On the death of Mosander, after his return, he was appointed professor and director of the Riks-Museum, Stockholm. It was because he held this post that von Berg wished to have him declared an exile. By means of energetically purchasing and collecting, and in consequence of the extraordinary richness of the Scandinavian peninsula in rare and remarkable minerals, the Mineralogical Museum at Stockholm, with help of the collections, valuable in certain directions, which have existed from Mosander's time, has in this way become one of the most considerable in Europe. In 1860 his old friend J. J. Chydenius, afterwards professor of chemistry at Helsingfors, joined him as collaborateur, and they made many excursions together. In 1860 his mother died, but he was not permitted to visit Finland even to bid her a last farewell. In 1861 he again visited Spitsbergen with Torell, on which occasion he had an opportunity of surveying the northern part of that archipelago, clearing up the main points of the geognosy of the country. This expedition was the first foundation of a true knowledge of the natural history of the Polar countries. In July 1863 he married Anna Mannerheim, a Finnish lady, and abandoned all thoughts of further Arctic journeys. "Circumstances, however," he says, "so arranged themselves that just from this time they were resumed by me, and on a greater scale than before." In 1863 he was asked by the Royal Academy of Sciences of Sweden to lead an expedition to Spitsbergen in the place of K. Chydenius, who was ill. He asked Docent Duner and Dr. Malmgren, of Lund, to join him. Starting in the spring of 1864, he completed the preliminary part of the survey for the arc of meridian, mapped the southern part of Spitsbergen, and collected new data as to fauna and flora. The sea was very free of ice; but an attempt at a high latitude was frustrated by meeting with seven boats with the crews of three wrecked walrus sloops, which compelled immediate return to Norway. In 1867 he visited Paris, having been commissioned, along with Prof. A. P. Ångström, to compare a normal metre and a normal kilogram, which had been made for the Swedish Government, with the prototypes preserved in the Conservatoire des Arts et Métiers.

Through Count Ehrensvard, Governor of Gothenburg, funds were raised, after several unsuccessful attempts, from Dickson, Ekman, Carnegie, &c., for another Polar expedition. State-Counsellor Count Platen, head of the Marine Department, took a special interest in the plan, and the iron steamer *Sofia* was placed at Nordenskjöld's disposal by the Government. On September 19, 1868, the *Sofia* attained the highest northern latitude which any vessel can be proved to have attained in the old hemisphere—namely, 81° 42′ N. The name of Mr. Oscar Dickson is always associated with that of Nordenskjöld; it was he who had contributed most liberally to the expedition of 1868, and Nordenskjöld was overjoyed when he voluntarily offered to equip another expedition to the same region. It was determined that the new expedition should have for its object to winter on the north-east coast of Spitsbergen, in order thence to push northwards in sledges on the ice. After a long set of inquiries as to whether dogs or reindeer should be used for draught purposes, Nordenskjöld decided upon reindeer. It was also decided, with Mr. Dickson's consent, that Nordenskjöld should go to Greenland to investigate the question of dogs, and this expedition was extended into a scientific one, three young Swedish men of science accompanying him. On this occasion he made a long journey into the interior of Greenland, almost equal in distance to that of Nansen undertaken some years later. Of this journey Nordenskjöld says: "I had here an opportunity of clearing up the nature of a formation which, during one of the latest geological ages, covered a great part of the civilised countries of Europe, and which, though it has given occasion to an exceedingly comprehensive literature in all cultivated languages, *had never before been examined by any geologist*." The same year, with some others, Nordenskjöld petitioned the Swedish Government to form a colony in Spitsbergen to work its mineral resources. This petition gave occasion for the Foreign Minister of Sweden to inquire of the Powers of Europe as to the annexation of Spitsbergen by Sweden. Russia alone objected, and Spitsbergen remains to the present day "No Man's Land."

The long-prepared new Polar expedition finally started in 1872. "The state of ice," says Nordenskjöld, "on the north coast of Spitsbergen was more unfavourable in 1872 than it had been at any time since the coast was frequented by the Norwegians." The reindeer escaped on the third day. The ship got frozen in on September 29, and the crews of six walrus sloops, which had also been frozen in, depended on Nordenskjöld for subsistence. Thus Nordenskjöld, instead of having twenty-four mouths to feed, was confronted with the almost insuperable problem of feeding 125. Seventeen of the walrus hunters, therefore, under the veteran Mathilas, reached Cape Thorsdem by boat, 200 miles distant, where they found all necessities at the quarters of the Swedish colony. Fortunately, two vessels escaped in November and took the crews of four vessels with them; but two men who remained died that winter. Nothwithstanding all this, the expedition yielded important scientific results, not the least important being the discovery of cosmic dust on the Polar ice. Extensive journeys along the north coast and across the inland ice of North-east Land were also made. In spite of the heavy expenses incurred in this voyage, Mr. Oscar Dickson declared that he was willing to "go on."

During the next few years, with his help, Nordenskjöld worked at the opening up of the Yenisei and the Siberian seas, which culminated in his ever-memorable voyage, accomplishing the North-east Passage in 1878–79. The voyage of the *Vega* is still fresh in the minds of all. Leaving Tromsö on July 21, she rounded East Cape on July 18, 1879, less than twelve months afterwards. The *Vega* found the Kara Sea free; and since that sea was so favourable, a considerable time was spent on dredging, sounding, and other scientific observations, including the re-mapping of the coast-line between Yenisei and Cape Sterlegof. Ice and bad weather detained him at Tainia Bay, but on August 19, the *Vega* rounded the northernmost point of Asia, Cape Chelyuskin. Next day the *Vega* was further north, namely, 77° 45′ N., which proved to be the most northerly point reached. At the Lena Delta, the *Lena*, which accompanied the *Vega* so far, turned southward up the river, and Nordenskjöld continued his voyage toward Bering Strait. On September 12, progress was stopped at the "North Cape" of Cook, where he turned back to Bering Straits in 1778, and Nordenskjöld was forced to winter off Pitlekai in 67° 07′ N., 123° E. Systematic scientific observations were carried on during the whole winter, spring, and following summer, till on July 19 they were released, and two days later rounded the eastern extremity of Asia with flying colours. On September 2, 1879, Nordenskjöld dropped anchor at Yokohama, whence the whole civilised world received the news that this man had accomplished what had so often been attempted during three centuries. For this brilliant exploit, Nordenskjöld was awarded a magnificent reception throughout Europe, and many honours were showered upon him, including his elevation to the rank of Baron in the Swedish Peerage. It is from the complete and striking success of this expedition that Nordenskjöld became popularly world-renowned.

In 1883 he undertook a second expedition to Greenland, penetrating further into the interior than any other explorer.

His success rested on the solid basis of his scientific instinct and training, and of his indomitable will and courage. It is to him that we owe the first real efforts at undertaking scientific research in the Polar regions, especially from the geological and mineralogical aspects.

His researches outside the Polar regions were also important. He discovered uranium in many varieties of coal, and he showed that fresh water could be obtained anywhere in Scandinavia at a depth of 100 feet through the Archæan rocks. This has been proved in 400 cases to be correct, and has been of great advantage to pilots, fishermen, lighthouse keepers, &c., living on small islands without water, and also for many factories. He remained a politician all his life. On account of refusing to suppress his opinions in this direction, he was rejected in 1867 as a candidate for the chair of mineralogy and geology in Helsingfors University, although he was unanimously recommended. As the son of a Swedish nobleman, he sat and voted in the Swedish House of Nobles; but, although so intimately associated with Sweden for the greater part of his life, he always referred to Finland as his "dear Fatherland." In his latter days he interested himself in South Polar exploration, and it must have been pleasing to him to know that his nephew was about to lead an expedition to the Antarctic regions.

W. S. BRUCE.

NOTES.

THE appointment of the Royal Commission on Tuberculosis was announced in Tuesday's *Gazette*. The Commission is composed of Sir Michael Foster, K.C.B., F.R.S., Prof. G. S. Woodhead, Prof. S. H. C. Martin, Prof. J. McFadyean, and Prof. R. W. Boyce. It is appointed to inquire and report with respect to tuberculosis:—(1) Whether the disease in animals and man is one and the same; (2) whether animals and man can be reciprocally infected with it; and (3) under what conditions, if at all, the transmission of the disease from animals to man takes place, and what are the circumstances favourable or unfavourable to such transmission.

THE International Engineering Congress was opened at Glasgow on Tuesday with an address by the president, Mr. James Mansergh, F.R.S. Referring to the value of the work of settling standard sections of important constructive materials, Mr. Mansergh remarked that this matter had been taken in hand by a joint committee of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute. Sir Benjamin Baker, with a specially-selected sub-committee, had charge of bridge and general building construction; Sir John Barry, with similar assistance, of railways; Mr. Denny, of shipbuilding; and Sir Douglas Fox, of rolling-stock. In the hands of these eminent engineers the work would be well handled. The address concluded with brief references to some of the chief subjects to be brought before the various sections of the congress. After the address members of the congress dispersed to the meeting rooms of their sections, where addresses were delivered by the sectional presidents, and papers were read.

THE forty-sixth general meeting of the German Geological Society will be held at Halle on October 4–7.

WE regret to announce that Dr. Charles Meldrum, C.M.G., F.R.S., late Director of the Royal Alfred Observatory, Mauritius, died on August 28 in his 80th year.

IT is stated that the exhibits of the German chemical industry at the Paris Exposition valued at 30,000*l*. have been presented to the Technological Institute of the University of Berlin.

THE Vienna correspondent of the *Times* states that the Emperor Francis Joseph has addressed an exceptionally cordial autograph letter to Prof. Edward Suess, the eminent Austrian geologist and politician, on his retirement from the Vienna University. The Emperor expresses his high appreciation of the work done by Prof. Suess in science, as an academic teacher, and as a public man, especially in the promotion of sanitary reform.

A TELEGRAM received by the American Consul at Christiania from the secretary of Mr. Baldwin's American Polar Expedition at Hammerfest, states that the Norwegian steamship *Frithjof*, which is one of the vessels employed by Mr. Baldwin, has returned to Hammerfest after fitting out and provisioning the expedition in Franz Josef Land. The expedition was landed at Cape Ziegler; when the *Frithjof* sailed from that point the conditions were favourable for pressing northwards, and Mr. Baldwin intended to begin his advance the next day.

THE Australasian Ornithologists' Union has been successfully inaugurated, and the first general meeting will be held at Adelaide in October or November. The objects of the Society are "the advancement and popularisation of the science of ornithology, the protection of useful and ornamental avifauna, and the editing and publication of a magazine or periodical, to be called *The Emu*, or such magazine or periodical as the Society may from time to time determine upon." Colonel W. V. Legge is the president-elect, and Mr. D. Le Souëf, Zoological Gardens, Melbourne, is the honorary secretary.

IN connection with the proposed Pasteur statue for Paris, the Paris correspondent of the *Chemist and Druggist* states that an attempt is being made to make it a national monument. The idea is that every Frenchman and resident in France should become a subscriber, and amounts from a halfpenny upwards will be received. Subscription-lists have been distributed in large numbers amongst heads of business-houses, manufactories, and Government offices, inviting them to collect sums, however small.

THE New York correspondent of the *Times* reports as follows upon experiments made at Havana to test whether yellow fever is carried by mosquitoes:—"Out of eight persons bitten by infected insects three have died, three have the fever and will possibly recover, one is not affected, while as regards the remaining case it is too early to make a diagnosis. The physicians are shocked at the result of the experiments. It was supposed that direct infection from mosquitoes caused only a mild form of the disease, and was a safe means of making the subjects immune. It is now definitely known that a man bitten by an infected mosquito after being inoculated with the serum introduced by Dr. Caldas, a Brazilian expert, has developed a genuine case of fever."

MAJOR RONALD ROSS, F.R.S., has just returned to England from West Africa, where he has been organising a campaign against mosquitoes and malaria. After inaugurating the campaign at Sierra Leone, Major Ross went to Lagos, where the Government actively concerns itself with all matters affecting the health of the community. In welcoming him to the colony, the Governor, Sir William Macgregor, referred to the measures taken to promote sanitary conditions, and thus increase the industrial prosperity of West Africa. Major Ross, in thanking His Excellency, said that he had been on the point of believing that his countrymen were becoming an unscientific and unpractical people. More than two years ago the fact that malarial infection is communicated by mosquitoes had been established by the most stringent scientific and experimental proof; and yet to his knowledge practically nothing had been done by his countrymen to act on this new information, in spite of its economic importance. He had, therefore, accepted with alacrity the offer of a large sum of money and other facilities from a generous philanthropist, and from Mr. A. L. Jones, Mr. John Holt, and others in England, to pay the expenses of practical work against malaria in Sierra Leone. This work had been commenced with every promise of success by his friend, Dr. Logan Taylor, and he had, therefore, felt himself free to proceed to Lagos to watch the work being done there. He was delighted to find that his pessimistic attitude was not justifiable as regards Lagos. He strongly eulogised everything that was being done against malaria by Sir William MacGregor, himself a distinguished member of the medical profession, by his most able friend, Dr. Henry Strachan, and by the enlightened medical profession and the Ladies' League in Lagos. He had witnessed the rapid and successful filling up of marshes by sand from the lagoons, and the rational utilisation of gaol prisoners for this useful work. He had inspected numerous houses rendered mosquito-proof by fine wire netting, which, while it did not exclude the breeze, as he expected it would, did exclude insects and damp, much to the comfort of the inmates. He highly commended the efforts of the Government to induce their officials and others to take quinine—a prophylactic which was much neglected in consequence of ignorance and faddism. Before the departure of Major Ross for Accra, Mr. C. Tambaci and other leading merchants promised to place an annual subscription of 150*l.* in the hands of the Governor to pay for a "Mosquito Brigade" for Lagos.

IN an address on tuberculosis given at the autumnal conference of the Sanitary Inspectors' Association last week, Sir James Crichton Browne referred to the subject of the relation between bovine and human tuberculosis, and Dr. Koch's recent statements upon it. In the course of his remarks, he said:—"Private investigations and experiments, laudable and significant enough though they might be, would not meet the requirements of the case, and the country was entitled to ask that a thoroughly competent public tribunal should, after a searching trial, determine whether the restrictions on trade that had been proved to be unnecessary should be abolished, or whether still more stringent restrictions than hitherto should be enforced to prevent human tubercular infection from animal sources. Dr. Koch had discredited the Report of the last Royal Commission on Tuberculosis, which up to now they had regarded as a standard work of reference; and it seemed highly desirable that the Report should be officially confirmed or declared to be obsolete." It was afterwards unanimously resolved:—"That this Association is of opinion that it is desirable that a Government inquiry should be instituted into the question as to the identity or the non-identity of human and bovine tubercle, and that a copy of this resolution be sent to the Right Hon. Walter Long, President of the Local Government Board."

READERS of NATURE are aware that kites carrying meteorological instruments have been employed for several years at the Blue Hill Observatory, Massachusetts, in the studies of the atmosphere carried on there. Until recently, no flights were made in winds having rates of less than twelve miles an hour; but Mr. A. L. Rotch, the Director of the Observatory, has now used the common method of creating an artificial wind and raising kites in comparatively calm weather by motion of the earth-end of the kite string or wire, the motion in this case being obtained from a rapidly moving tug. The apparatus employed consisted of a portable windlass containing 3600 feet of wire, three Hargrave kites having a total lifting surface of 80 square feet, and an instrument for recording temperature, pressure and wind velocity and humidity. This outfit was installed on the upper deck of a tug in Massachusetts Bay on August 22. Two flights were made, and the greatest heights reached were 2630 and 2670 feet. With more wire and kites much greater heights could have been obtained. The natural wind varied between six and eleven miles an hour, and was much too light to elevate the kites and apparatus, but by steaming against the wind the velocity relative to the tug and kites was increased to between fourteen and nineteen miles an hour. In this artificial wind the kites rose easily, and so steadily that they could be let out from and hauled into hand without the slightest risk to kites or instruments. The kites were very sensitive to alterations of the course of the tug, and began to fall whenever the course varied 30° to 50° on either side of the mean direction of the wind. The experiment shows that meteorological records at great heights may easily be obtained during calms or very light winds by means of kites flown from a rapidly moving steamer; and that it is now possible for the observer and student to work uninterruptedly under almost all conditions of wind and weather.

THE Kew *Bulletin of Miscellaneous Information* for November and December 1899 has just been received. In spite of its belated publication, several of the contributions to it are noteworthy. Of current interest is a paper on the two West Australian woods, jarrah (*Eucalyptus marginata*) and karri (*Eucalyptus diversicolor*), which are now largely used, especially for wood paving. Over nearly all the world, and more particularly in England, these woods are in increasing demand. A Department of Woods and Forests has now been established, and its general usefulness as regards the control and management of the enormous natural wealth of the timber resources of the colony is beginning to be recognised and appreciated. Something over one million acres of forest land have now been leased from the Government for the purpose of acquiring the timber upon them. This is chiefly jarrah country, and embraces some of the finest forests of that particular kind of tree, which is the principal timber-tree in Western Australia. There are other timbers in the forests which are equally, if not more, valuable for their own special purposes, but for general constructive works, necessitating contact with soil and water, the timber of this tree stands foremost. The karri is not so well known as the jarrah owing to the limited area and, at present, comparative inaccessibility of its field of growth. It is the giant tree of Western Australia, if not of the whole Australian continent. For street blocking karri timber is most valuable, and for this purpose seems to be equal to, if not better than, the jarrah, in that its surface, by the wear caused by the traffic, does not render it so slippery for the horses' feet. As is well known, this timber is now largely used for London street paving.

SOME farmers believe that the moon has a direct effect upon vegetation, and that the time of sowing seeds should be regulated by the lunar phases. No accurate experiments appear to have been made to investigate this influence; and a note in the U.S. *Monthly Weather Review* points out that the belief is one that has come down to us from very early times, and began before accurate observations were recorded. Two proverbs relating to the influence of the moon upon vegetation, as handed down to us through folk-lore, read as follows:—

> "Go plant the bean when the moon is light,
> And you will find that this is right;
> Plant the potatoes when the moon is dark,
> And to this line you will hark."
> (*Dunwoody, Weather Proverbs.*)

> "Sowe peason and beans in the wane of the moone
> Who soweth them sooner, he soweth too soone."
> (*Werenfels, Dissertation upon Superstition*, 1748.)

Here are two different sayings as to the phase of the moon during which to plant: (1) a bright moon for beans and a dark moon for potatoes; (2) a waning moon for peas and beans. Another proverb states that sowings should always be made at the period of an increasing moon. Further astrological considerations are also often introduced, and if they were permitted to determine the time of planting seeds, farmers would find that there are only one or two full working days in a whole month when the moon and the signs are favourable. Fortunately, farmers as a class wisely busy themselves with seed-sowing when the soil (not when the moon) allows it, and have more faith in laborious cultivation, manure, rainfall and temperature than in lunar influence.

MR. J. HALL-EDWARDS, who was surgeon-radiographer to the Imperial Yeomanry Hospital, South Africa, described some of his experiences as to the value of Röntgen rays in warfare at the recent meeting of the British Medical Association. He found that the plan of obtaining the current for charging the accumulators from a dynamo connected with a belt to a foot motor of the bicycle type was altogether impracticable, as no one could work the bicycle arrangement long enough to be of much use. A small oil engine was used instead of the foot power, and worked very satisfactorily. As to the results of the introduction of Röntgen rays into military surgery, Mr. Hall-Edwards remarks:—"With the friendly aid of these rays, we are enabled to record the effects of small-bore projectiles under the various conditions which occur in actual warfare. We are enabled to localise the position of a bullet or other foreign body with absolutely scientific accuracy; and, if our present knowledge be used to its fullest extent, we can see the condition of the parts as plainly as we could do were the soft tissues composed only of transparent gelatine. These facts being recognised, it is easy to see that the application of the rays to military surgery must produce results of the greatest possible value for future guidance, and that their complete application in a great war—such as we are at present engaged in—must prove of inestimable service in increasing our knowledge upon this most important subject. Many of the time-worn, useless and dangerous methods of finding the whereabouts of hidden bullets may now be forgotten; for with these rays we have at our disposal an aseptic, scientific and absolutely accurate method of localisation, which may be improved, but which even now is as near perfection as our present knowledge can make it. There can be little doubt that, in the face of the new facts brought to light by means of these rays, military surgery will have to be rewritten, and the advance made will mark an epoch in its progress."

"I RETURNED, and saw under the sun, that the race is not to the swift, nor the battle to the strong," wrote the wise man. Writing in the same prophetic vein, M. J. de Bloch in the current *Contemporary Review*, and Mr. H. G. Wells in the *Fortnightly* for September, depict in graphic colours the transformation which the immediate future will witness in the methods of warfare. Both writers are convinced that the military tactics of the past are irretrievably dead. The effective soldier of the future will be a man whose capacity for individual action has been cultivated and developed. The day for all the picturesque accompaniments of war is done, and exhibitions of mere brute courage will be of no avail. Mr. Wells takes into account the resources which modern science has made available for the business of war, and proceeds to anticipate the most likely directions that future advances will take. Of one thing he leaves his reader in no doubt, victory is bound to be with the nation that most sedulously attends to the education of its people in the scientific method. The great war of the future will be fought by citizens familiar with destructive instruments of precision, who have learnt to utilise all the accessory helps which science is gradually perfecting. There will be few professional military men of the type of to-day in the ranks of the victorious nation. In Mr. Wells's words, "the warfare of the coming time will really be won in schools and colleges and universities, wherever men write and read and talk together. The nation that produces, in the near future, the largest proportional development of educated and intelligent engineers and agriculturists, of doctors, schoolmasters, professional soldiers, and intellectually active people of all sorts; the nation that most resolutely picks over, educates, sterilises, exports, or poisons its People of the Abyss; . . . the nation in a word, that turns the greatest proportion of its irresponsible adiposity into social muscle, will certainly be the nation that will be the most powerful in warfare as in peace."

WE have received a report by Prof. Elster on progress in the study of Becquerel rays, reprinted from Dr. Eder's photographic *Jahrbuch* for 1901. It is a summary of experimental work done in this direction subsequent to the report by the same author for the previous year.

A REPRINT from the *Proceedings* of the South London Entomological Society contains a paper on the ova of Lepidoptera, by Mr. F. Noad Clark. Mr. Clark has been highly successful in photographing these eggs, especially when account is taken of the difficulty of obtaining good photographs of opaque microscopic objects.

FROM the annual *Report* for 1900 we learn that the Botanical Exchange Club of the British Isles now has a membership of fifty. During the year 373 covers were sent in, 67 containing Rubi, 49 Hieracea, and 14 Euphrasiæ, the total number of specimens received and distributed being 4575. The report contains a large number of notes of new varieties, new localities, and records confirming the persistence of rare species and varieties in previously recorded habitats.

A THESIS recently presented to the Paris Faculty of Science by M. Henri Bénard deals with the cellular distribution of eddies produced in liquid films when convection currents are set up. Although the phenomena herein described have been previously recorded, but little appears to have been done in submitting them to systematic observation. These phenomena consist in the property that when a horizontal film of liquid has its lower surface heated to a higher temperature than its upper surface, the convection currents divide the liquid into a series of more or less regularly formed hexagonal cells, the liquid flowing down the sides and up the middle. The experiments have been made chiefly with spermaceti, various methods being adopted in order to make the cellular structure visible by the addition of solid particles. The distribution of motion is found to be permanent and stable, and M. Bénard has determined all the geometric, kinematic and dynamic elements of the motion.

Bulletin No. 44 of the Agricultural Department of Madras consists of notes on the domesticated cattle of that Presidency by Mr. J. D. E. Holmes, of the Veterinary Department. The various breeds found in this part of India are recorded and briefly characterised.

A RECENT issue of the *Proceedings* of the U.S. Museum (No. 1228) is devoted to the consideration of the relationships of the jumping-mice to the jerboas on the one hand and to Sminthus on the other. The author, Mr. M. W. Lyon, comes to the conclusion that the first-named animals typify a family (Zapodidæ) by themselves, and that in that family should be included the genus Sminthus, which was referred by Alston to the mice and rats (Muridæ). In No. 1227 of the same publication Mr. D. W. Coquillett discusses the classification of the flies (Diptera).

THE first part of a list of the birds in the Indian Museum, Calcutta, by Mr. F. Finn, has been received. Although this little work is nothing more than a classified list of species (containing in this part the families Corvidæ, Paradiseidæ, Ptilonorhynchidæ, and Crateropodidæ), with a record of the specimens by which each is represented in the Calcutta Museum, it has a considerable value to ornithologists on account of the inclusion of a list of "type" specimens. How extensive must be the series of such types in the Indian Museum may be inferred from the fact that there are no less than sixty-six in the Corvidæ and Crateropodidæ alone. Bearing in mind the liability to damage and decay of almost all natural history specimens in the climate of Lower Bengal, the question must suggest itself to all ornithologists whether it is advisable that such valuable specimens should remain permanently in Calcutta.

OUR American contemporary *Science*, for August 16, contains the report of a lecture on regeneration and liability to injury in animals, delivered by Prof. T. H. Morgan at Columbia University. In this lecture (which forms the first of a series) Prof. Morgan commences by discussing the common belief as to the existence of a definite relation between the liability of an animal to injury and its power of regeneration, and the idea that those parts of an animal most subject to injury are those in which the power of regeneration is most developed. With regard to the latter portion of the popular belief, Prof. Morgan has no hesitation in condemning it as unsound. The fact that in animals with "breaking joints" the regeneration may take place both above and below such joint is, he states, a sufficient demonstration of the falsity of the belief. With regard to the other part of the proposition, Prof. Morgan adduces evidence to show that the power of regeneration is characteristic of groups rather than of species; and that when exceptions do occur it is not in the case of forms specially protected from injury. "If this is borne in mind, as well as the fact that protected and unprotected parts of the same animal regenerate equally well, there is established, I think," says the lecturer, "a strong case in favour of the view that there is no necessary connection between regeneration and liability to injury."

TWO weeks ago announcement was made that the President of the Board of Trade had appointed a committee to inquire and report upon the means by which the State or local authorities could assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland. It was gratifying to record this sign of interest in the scientific aspects of our fisheries, and the appointment has not been made too early, for we learn, from a letter which Mr. W. Garstang contributes to the *Western Morning News* of August 28, that the Technical Instruction Committee of the Cornwall County Council has curtailed the grant for fishery purposes which it has been giving for the past few years, apparently as a prelude to further restrictions of the work done by the Sub-Committee for Fisheries. Perhaps the appointment of the Board of Trade committee will induce the Cornish authorities to reconsider their recent action, for they should see that the subjects which the committee have to consider are those which their own fishery expert has had under consideration since he began his investigations. Cornwall has in fact been doing what every local authority having fishery interests within its area ought to do; and to limit the scientific work it has instituted would be an unfortunate and altogether unsatisfactory conclusion of an enlightened policy. It is difficult to point to direct benefits received from such work, but the subjects of instruction and experiment carried on under the auspices of the Cornish committee ought to meet with the approval of far-seeing practical men. Our fisheries are declining at a very rapid rate, and scientific advice is needed to show how waste can be reduced and supplies increased. As Mr. Garstang remarks, there is no valid reason why biology, with suitable means and opportunities, may not do as much for our fisheries as chemistry and physics have achieved for our manufactures. "It should not be forgotten that the vast oyster fisheries of France at the present day are to a large extent the outcome of a commission given to a man of science, M. Coste, by the French Government exactly fifty years ago, when 'it is hardly an exaggeration to say there was scarcely an oyster of native growth in France.' Coste successfully introduced the Italian methods of culture into France, and his countrymen modified them to suit the local conditions, though years were spent in the needful preliminary experiments. No one to-day would assert that those years of experiment were ill-spent, although at the time their cost was doubtless greater than their immediate return."

"BRITISH RAINFALL" (for 1900) appears for the first time without the name of the late Mr. Symons, the editors of the rainfall records now being Mr. H. Sowerby Wallis and Dr. H. R. Mill. The subjects of special contributions to the new volume are the Ilkley flood of July 1900, and the development of rainfall measurement in the last forty years. In the latter article Dr. Mill gives an interesting account of the various kinds of rain-gauges which have been used, and states some of the general results obtained. Copper is generally adopted as the material for rain-gauges because it is not affected much by weather, its surface is smooth, and it is not easily broken. Ebonite is better, but it is more costly; zinc, though cheaper, deteriorates in the neighbourhood of towns or manufacturing districts. Dr. Mill suggests, however, that it might be possible to find a suitable substitute for copper among such substances as pure nickel, enamelled iron, and celluloid, with modern enamel paints. The size of the rain-gauge is immaterial, and the 5-inch gauge has been adopted as the standard because it does not collect an embarrassingly large or inconveniently small volume of water for measuring. The exposure and elevation of rain-gauges have formed the subjects of many experiments and reports, and Dr. Mill thus sums up the observations:—"The outcome of the whole matter is, that over a broad, flat surface, whether a natural feature of the ground like a plain, a plateau or flat-topped hill, or an artificial erection like a very extensive flat roof, increase of height produces no diminution in the amount of rain caught by a gauge having its mouth one foot above the surface on which it rests. But any abrupt change in the slope of the surface near the gauge, whether it be an embankment across a valley, a cliff, or a steep roof, or tower, allows the wind to set up eddies, or acquire an increased velocity, and so to reduce the amount of rain received in a horizontal gauge." These principles are clear enough, and they show the need for the adoption of a uniform height of gauge by all members of the rainfall organisation. At present it appears that not half the gauges in use are placed at exactly the standard height.

MESSRS. SWAN SONNENSCHEIN AND CO. have published a third and revised edition of "Land and Fresh-water Shells," by Mr. J. W. Williams, with a chapter on the distribution of the British land and fresh-water Mollusca, by Mr. J. W. Taylor and Mr. W. Denison Roebuck.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. G. Nicholson; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. J. McCarthy; a Short-toed Eagle (*Circaëtus gallicus*) from the Atlas Mountains, presented by Captain W. R. Taylor; a Passerine Parrot (*Psittacula passerina*) from South America, presented by Mr. W. C. Stronge; two Turtle Doves (*Turtur communis*), British, presented by Miss L. Cox; a Greek Tortoise (*Testudo graeca*) from South Europe, presented by Mr. Balfour Read; a Neumann's Baboon (*Cynocephalus neumanni*) from Central Africa, a Nisnas Monkey (*Cercopithecus pyrrhonotus*) from East Africa, a Striped Hyæna (*Hyaena striata*, var.) from North Africa, three Pale Fennec Foxes (*Canis pallidus*) from the Soudan; a Brazilian Caracara (*Polyborus brasiliensis*) from South America, a Black-headed Conure (*Conurus nanday*) from Paraguay, an Egyptian Monitor (*Varianus niloticus*) from North Africa, two Brazilian Tortoises (*Testudo tabulata*) from South America, two Sculptured Terrapins (*Clemmys insculpta*) from North America, three Muhlenberg's Terrapins (*Clemmys muhlenbergi*) from North America, a Pennsylvania Mud Terrapin (*Cinosternum pennsylvanicum*) from North America, three Laughing Kingfishers (*Dacelo gigantea*) from Australia, two White-capped Tanagers (*Stephanophorus leucocephalus*) from Argentina, three Striated Tanagers *Tanagra striata*) from Buenos Ayres, four Palm Tanagers (*Tanagra palmarium*) from South America, a King Snake (*Coronella getula*) from North America, two Ocellated Sand Skinks (*Chalcides ocellatus*) from North Africa, deposited; four Lesser Snow Geese (*Chen nivalis*) from North America, two Mute Swans (*Cygnus olor*), European, purchased; a Thar (*Hemitragus jemlaicus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTRUM OF NOVA PERSEI.—A communication from Prof. Pickering to the *Astronomische Nachrichten* (Bd. 156, No. 3735) gives particulars of the examination of recent photographs of the spectrum of the Nova taken at the Harvard College Observatory. The reductions show that, as has been the case in previous Novæ, the object has been gradually changing into a gaseous nebula. The resemblance to the nebula N.G.C. 3918 was so close on June 20 that no marked difference in the two spectra was noticeable. The main point of divergence is in the relative intensity of the chief nebular line at λ5007, which in N.G.C. 3918 is about eight times as bright as Hβ, while in the Nova these two lines are about equal in intensity.

The following lines are common to both bodies:—

3869	4688
3970, Hε	4862, Hβ
4102, Hδ	4959
4341, Hγ	5007

and with the above-mentioned exception of λ5007 are of similar intensity. Four bright lines between Hγ and Hβ appear faintly in the Nova, and are not present in the nebula, while one, at λ4364, is seen in the nebula, but not in the Nova, perhaps owing to the proximity of Hγ.

NEW DOUBLE STARS.—*Bulletin* No. 3, from the Lick Observatory, contains a list of 94 new double stars discovered by Mr. R. G. Aitken, with the 12-inch and 36-inch telescopes, the majority of the measures being obtained with the larger instrument. The series has been compared with Prof. Burnham's Catalogue to ensure the absence of duplicate records of previous discoveries. Classified according to distance of their components the 94 pairs show the following grouping:—

Under 0″·25	3
0·50	23
1·00	47
2·00	73
Over 5·00	1

SIX STARS WITH VARIABLE RADIAL VELOCITY.—Prof. W. W. Campbell gives particulars in *Bulletin* No. 4 of the Lick Observatory of six additional spectroscopic binaries, of which variable velocity in the line of sight has been determined from spectra obtained with the Mills spectrograph of the Lick Observatory. The details of the measures are given below:—

Star.	Extreme velocities (kilometres).	
π Cephei	−37	−5
$o_1$31 Cygni	−12	+3
ξ Piscium	+25	+35
τ Persei	+10	−4
ξ_1 Ceti	−9	+4
ε Hydræ	+43	+32

CAUSES OF THE VARIABILITY OF EARTHSHINE.—In the May number of the U.S. *Monthly Weather Review*, Mr. H. H. Kimball gives an interesting discussion of the probable causes of the earthshine observed on the moon's shadow side some few days previous to, and following new moon. With the idea that the amount of light reflected from the earth to the moon will vary considerably according to the condition of the earth's surface and atmosphere, a special projection chart of the earth has been prepared, showing the configuration of the continents, oceans, &c., and general atmospheric conditions (clouds, &c.), on a certain evening when the earthshine was specially prominent. If the bright portion is snow-covered, it will reflect more than a continent of forest and vegetation, and much more than a large extent of water.

A factor of considerable importance is the varying distance of the moon, and it is stated that 52 per cent. of the change in intensity of the earthshine is due to the eccentricity of the moon's orbit, and this is probably much greater than could be expected from any increase or diminution in the average cloudiness over the hemisphere of the earth reflecting light to the moon.

SOLAR RADIATION.

SOLAR radiation is a subject which has more than scientific interest. It is the source of all the energy which maintains the economy of our globe. It lights and heats the other members of the planetary system. But, after accomplishing this, only an infinitesimal proportion of the total radiation has been used. The remainder, in so far as we know, is wasted by uninterrupted dissipation into space.

The subject can be regarded and studied from either the solar or the terrestrial point of view. In terrestrial physics everything may be said to depend on the energy which, in one form or another, is supplied by the sun's rays. It is the revenue of the world, and it is of fundamental importance for us to know at what rate it falls to be received.

Roughly speaking, the surface of the earth is occupied to the extent of one-fourth by land and three-fourths by sea. Therefore at least three-fourths of the surface which the earth presents to the sun is at the sea-level. Consequently the rate at which the sun's radiant heat arrives at the sea-level is the fact which it is of the greatest economical importance to ascertain.

In considering this problem we have to answer two questions: What is the best experimental method of determining the heating power of the sun's rays at any place? and What is the best locality for making the experiment? Let us take the last first. The energy which a radiation communicates to a surface is greatest when it strikes it perpendicularly. At every moment the sun is vertical over one spot or another of the earth's surface. Therefore our first step should be to choose a locality where the sun passes through the zenith at mid-day.

Before reaching the sea-level the sun's rays have to pass through the whole thickness of the atmosphere. It is a matter of every-day observation that the atmosphere varies in transparency. The second condition is therefore to put ourselves in the position of greatest advantage as regards atmospheric conditions. Clouds and similar visible obstructions are of course excluded. The air should be motionless, the sky should be clear and of a deep blue colour in the regions remote from the sun and should contain nothing that can be called haze, or that interferes with the definition of the sun or other heavenly bodies.

From inspection alone we can only approximately ascertain what are the most favourable meteorological conditions. For this reason it is necessary to multiply observations and never to miss fine weather. In the end we cannot fail to approach nearer and nearer to the exact determination of the maximum heating power of the sun on the earth's surface at or near the sea-level, in so far as the degree of perfection of our instrumental resources permits. This limitation imposes on us the duty to continue observations, not only until the best natural conditions have been found, but also so long as the instruments or experimental methods appear to be capable of improvement. If we suppose for one moment that we have arrived at the point where no further improvement is possible, then the result of our work is the determination of the rate at which unit area of the earth's surface at or near the sea-level receives heat from the vertical sun in unit time.

There is no question here of how much is lost on the way from the sun. All that is sought, and the most that is ascertained, is how much arrives. If we multiply this by the area included in the great circle of the earth we have the amount of radiant heat which we can count on as being supplied to the whole earth in unit of time. This is the constant which is of greatest importance in physical geography.

When we have ascertained the supply of radiant heat which reaches the earth's surface, we have to inquire what becomes of it. If the heat were to accumulate the world would become uninhabitable. It cannot be doubted that long ago the earth, in this respect, arrived at a condition of equilibrium which is maintained with very slight oscillations. The fundamental principle of this state of equilibrium is that the heat which the whole earth receives from the sun in the course of a year also leaves it in the course of a year, so that, taking one year with another, the sum of the heat remains the same.

When we study the details of the annual dissipation of heat we find that the atmosphere, and especially the aqueous vapour in it, performs a very important part. Although practically transparent to the heat-rays passing from the sun to the earth, it is very opaque to those leaving the earth to pass outwards. They are powerfully absorbed and the temperature of the atmosphere is thus raised considerably above that which it would have if it were as transparent to the leaving rays as it is to the entering ones. This has no effect in permanently detaining any of the year's supply, it still disappears in the year, but not before it has produced important climatic effects.

We see in this differential behaviour of the atmosphere towards the incoming and the outgoing rays an example of Kirchoff's law, in virtue of which a body absorbs by preference the rays which it itself emits. It is exceedingly unlikely that any portion of the rays coming directly from the sun proceed from highly heated water or water vapour; we should therefore not expect the water vapour in the atmosphere to absorb them to any appreciable extent. When, however, they strike the surface of the earth, whether it be land or sea, they are abundantly absorbed. The blue water of the ocean transmits the sun's visible rays to a considerable depth. In experiments made by the writer on board the *Challenger*, a white surface, about four inches square, was clearly visible at a depth of 25 fathoms. The total length of the path of the incident and reflected ray was 50 fathoms; therefore the sun's rays which strike the sea have a thickness of at least 100 metres to work on. When they strike the land, the direct effect is superficial, but the absorptive power of a surface of soil is very much greater than that of a surface of water, and it frequently attains a very high temperature. Even in the driest countries the soil is moist, and it may be that, ultimately, the surface of every particle of the soil is a water surface. Whether this be so or not, when a land surface cools, the heat of low refrangibility which it radiates proceeds to a very large extent from water, and it is accordingly abundantly absorbed by the water vapour in the lower layers of the atmosphere. In the absence of mechanical mixture by wind, these layers can lose it only by passing it on by radiation to higher layers which contain moisture, whence it ultimately escapes into space. This accumulating function of the atmosphere provides that while every portion of the earth's surface receives heat intermittently it loses it continuously.

As the heat of the atmosphere is due to contact with, or radiation from, the surface, it must be taken from the supply that reaches the surface of the earth. Further, wind and all mechanical atmospheric effects are due to differences of density, and these are produced, not only by the thermal expansion and accompanying rise of temperature of the air, but also, and without change of temperature, by the mixture with it of a lighter gas. Such a gas is the vapour of water, and the water which supplies it is at the level of the sea. Therefore the sun's heat which arrives at the surface of the earth at or near the sea-level has to maintain not only the temperature of the surface of the globe, it has also to maintain all the mechanical manifestations of the air and the ocean. This is the ground for asserting, as above, that the only constant which is of interest in terrestrial physics is the rate at which the vertical sun heats unit area of the earth's surface at the sea-level.

The instruments used for measuring the thermal effect of the sun's rays must fulfil certain conditions. The area of the sheaf or bundle of rays collected must be accurately known; and provision must be made for the exact measurement of the thermal effect produced by them in a given time. The thermal effect produced is measured by a mass of some substance and either by the change of temperature produced in it or by the change of its state of aggregation. Actinometers, such as those of Herschel, Pouillet, Violle, Crova, are instruments of the first kind. The ice calorimeter used by Exner and Röntgen and the steam calorimeter of the writer are instruments of the second kind. The thermal mass of the substance affected is conveniently expressed in terms of the thermally equivalent weight of water, which is called its water value. In the actinometer the change of temperature is either measured by a separate thermometer or the actinometer is itself a thermometer the calorimetric constants of which have been ascertained. In instruments of the second class no thermometer is required; the thermal effect is measured by the mass of water-substance which changes its state in a given time either from ice to water or from water to steam, both being at the same temperature. In the ice calorimeter the quantity of liquefaction is measured by the change of volume, as in Bunsen's calorimeter; in the steam calorimeter the generation of steam is measured by the weight or volume of the distilled water produced. The steam calorimeter was described recently in NATURE (vol. lxiii. p. 548), and it is unnecessary to repeat it here. It acted quite satisfactorily in the writer's hands in Egypt in May 1882, and it has since been giving good results in the hands of Mr. Michie Smith at the observatory of Kodaikanal in South India, at an elevation of about 7000 feet above the sea. Theoretically, the ice calorimeter is as good as the steam calorimeter, but in applying it to the measurement of the sun's radiant heat it has a practical defect. At the moment before exposure, the ice in the calorimeter is frozen to the inner surface of the metal plate, the outer surface of which receives the sun's rays. The first effect of exposure to the sun is that the ice is detached from the plate. The intervening water introduces perturbations which are not easily allowed for.

The fundamental principle of the actinometer is analogous to Newton's second law of motion; when a body is engaged in the exchange of heat between itself and any number of other bodies, each exchange takes place independently of the others. The rate of exchange in each case depends on the difference of temperature between the two bodies and takes place on the principle that equal fractions of heat are lost or gained in equal times. A body cooling in the air is always subject to at least two quite independent sources of loss of heat, namely, radiation between itself and the surrounding objects and conduction between itself and the contiguous air. In ordinary circumstances the rate of loss of heat by radiation is subject to but little variation, but that due to conduction is subject to continual variation owing to the varying rate at which the air actually in contact with the thermometer is renewed. It is not to be expected that a body subject to at least two independent sources of loss of heat will cool in the same way as it would if exposed to only one, any more than it is to be expected that a body acted on by two forces will move in the same way as if it were impelled by only one of them. The composition of rates of cooling is like that of velocities in the same straight line; the resultant rate is the net, or algebraic, sum of all the rates. When the actinometer is exposed to the sun, its temperature rises at first rapidly, and then more slowly until, if the experiment is sufficiently prolonged, it becomes stationary. The temperature is noted at equal intervals of time. The sun is screened off, either after the temperature has become stationary or beforehand, and the temperature is observed at equal intervals during cooling. Whenever the thermometer is at a higher temperature than its enclosure, it is cooling. Therefore when it is exposed to the sun's rays, and its temperature rises ever so little above that of the enclosure, cooling begins; and what is observed in the first operation is, not the rate of heating by the sun's rays, but that rate diminished by the rate at which the thermometer is cooling. Hence, when the two series of observations have been made and tabulated, the rate of rise of temperature when that of the thermometer is, say, 2°, 4° or 6° above that of the enclosure is found. Similarly, the rate of fall of temperature when the temperature of the thermometer is 2°, 4° or 6° above that of the enclosure during cooling is found. Three pairs of rates are thus obtained. The sums of all three pairs of rates should be alike, and each gives a value of the rate at which the temperature of the actinometer would rise when exposed to the sun if there were no cooling. The rule is the same whether the temperature is allowed to rise to the stationary point or not. A distinction is often made between the *static* method, when the experiment is continued until the stationary temperature is arrived at, and the *kinetic* method, when it is interrupted before that temperature is reached. This distinction rests on no substantial difference; at the same time it is convenient to retain the designations to distinguish the manipulative processes.

Were the protecting enclosures, such as the double spherical shell packed with melting ice, used by Violle, or the thick metal shell used by Crova, perfectly efficient, then it would not be necessary to make a separate cooling experiment in connection with every heating one. The necessity for it is due to the fact that, when the sun's rays are introduced, the temperature of the air in the enclosure no longer is, and it cannot be, at the temperature of the enclosing shell; nor can it remain motionless, as it is when at a constant temperature in the shade. These perturbations, which cannot be avoided, so long as there is air in the enclosure, make it impossible to apply a rate of cooling determined beforehand. It is necessary on each occasion to determine the actual integral rate of cooling during the particular experiment.

If the actinometer could be so arranged that the rate of cooling should not be affected by the introduction or exclusion of the sun's rays, the static method could be adopted without hesitation, and the instrument would become a valuable one for continuous self-recording observations. Their value would be mainly relative. The absolute value of the sun's heat radiation, as it reaches the surface of the earth, has to be determined by other means. When it has been ascertained in the most favourable circumstances it does not vary, excepting in the annual cycle of the earth's revolution. The diurnal variation, as shown by registering actinometers, would have a great local importance. Crova, in the long series of valuable observations which he has made since 1875 at Montpelier, has, in fact, put this principle in practice.

Very important observations have been made in the neighbourhood of Chamonix by Violle and afterwards by Vallot. The Annales de l'Observatoire météorologique du Mont Blanc contain, in vol. ii., several interesting reports on the results of these observations. They were made simultaneously at Chamonix and at certain stations on Mont Blanc. The first series of observations was made in 1887 on July 28, 29 and 30, and the instruments used were two "absolute actinometers" of Violle (*Ann. Chim. Phys.* (1879) [5], t. xvii.).

The great advantage of such experiments is that they are made simultaneously at two stations situated at very different altitudes. At the higher of the two the average barometric pressure is 430 millimetres, so that 33/76 of the whole atmosphere are below the observer, and this portion contains nearly all the aqueous vapour. Above him there is a little more than one-half, and that much the simpler and purer half of the atmosphere. In it aqueous vapour is almost absent. The summit of Mont Blanc is 4807 metres and the station at Chamonix is 1087 metres above the sea. The layer of the atmosphere separating them has, therefore, a thickness of 3720 metres, and it can be visited at any point in its thickness. M. Vallot has acquired a personal acquaintance with this layer of air which can only be obtained by devoting a number of years to living in it and observing it. It is this intimate and continuous acquaintance with so large a proportion of the earth's atmosphere that entitles the observations and conclusions of M. Vallot to especially great weight.

The main results of Vallot's observations are as follows. The ratio between the heat received in the same time by the same area exposed perpendicularly to the sun's rays on Mont Blanc and at Chamonix was found to be 0·82 to 0·85, which agreed well with the proportion found by Violle in 1875. The value of the solar radiation found was, however, much lower than that found by Violle. The maximum values observed by Vallot were 1·56 gr.° C. on Mont Blanc and 1·33 gr.° C. at Chamonix, whilst Violle found 2·39 gr.° C. on Mont Blanc and 2·02 gr.° C. at the Glacier des Bossons in the valley. Violle's observed values are therefore half as great again as Vallot's. No explanation of the cause of this discrepancy is offered, but it is pointed out that the values observed by Crova at Montpelier are more in accordance with Vallot's than with Violle's. They are interesting in themselves and are worth quoting. They relate to the year 1895, the summer of which was very hot.

Intensity of solar radiation observed by M. Crova at Montpelier in 1895, in gramme-degrees per square centimetre per minute:—

Season.	Means.				Absolute maxima.	
	Monthly.			Seasonal.		
Winter	1·02	1·12	1·15	1·09	1·32	January 28.
Spring	1·20	1·13	1·13	1·15	1·38	May 12.
Summer ...	1·22	1·14	1·19	1·18	1·42	July 24.
Autumn ...	1·30	1·20	1·02	1·17	1·41	September 8.

The subject was taken up again by Vallot in 1891, and this time he used the mercury actinometer of Crova (*Ann. Chim. Phys.* 1877 [5] xi., 461).

The result of the experiments in 1891 was in the main confirmatory of those obtained in 1887. In the following table the intensities of solar radiation on September 19, 1891, are given as observed on Mont Blanc and at Chamonix:—

Hour.	9 a.m.	10.	11.	Noon.	1 p.m.	2.	3.
Observed Radiation. On Mont Blanc	1·34	1·30	1·36	1·38	1·34	1·33	1·31
Observed Radiation. At Chamonix	1·11	1·16	1·19	1·15	1·16	1·09	1·01
Ratio of intensities.	0·83	0·89	0·87	0·83	0·87	0·82	0·77

The mean value of the ratio of the intensities is 0·84, as before. The values of the intensity of radiation are rather lower than those found in 1887.

In the year 1896 Prof. Ångström, of Upsala, made observations on the peak of Tenerife with a special form of actinometer depending on the heating of metal plates. He made observations at three different elevations, namely, at Guimar, 360 metres, Cañada, 2125 metres, and at the summit, 3683 metres. Reduced to a uniform thickness of one atmosphere corresponding to a pressure of 760 mm., the intensity of radiation by the vertical sun was found to be at Guimar 1·39, at Cañada 1·51, and at the summit 1·54 gramme-degrees per square centimetre per minute. These values agree more closely with the values found in 1887 by Vallot than with those of 1891. But the values found by Crova, Vallot and Ångström are all of the same order.

The writer's observations with the steam calorimeter in Egypt in May 1882 were undertaken with the object of ascertaining the maximum rate of distillation near the sea-level under the most favourable circumstances. This occurred during the forenoon of May 18, when the meteorological conditions were as favourable as they could be. The sun shone steadily in a cloudless sky, and the air was motionless. The shade temperature reached 40°·5 C. in the course of the day. Time was taken as portions of 5 cubic centimetres were distilled. The shortest time in which this quantity passed was 3m. 20s. This is at the rate of 1·5 c.c. per minute, and it occurred twice in the forenoon, namely, at 10h. 37m. and at 11h. 23m. As the collecting area of the reflector was 904 square centimetres, this corresponds to 16·6 c.c. distilled per minute per square metre. If we apply a correction for 20° zenith distance it becomes 17·04 c.c. The evaporation of 17·04 grammes of water at 100° C. requires 9116 gr.° C. of heat, so that the heat actually collected and used in making steam was at the rate of 9116 gr.° C. per square metre or 0·9116 gr.° C. per square centimetre per minute. Converting 9116 gr.° C. into work at the rate of 0·425 kilogramme-metres per gramme-degree, we obtain as the realised working value 3875 kilogramme-metres per minute or 0·87 horse-power per square metre. The reflector consists of one mirror inclined at an angle of 45° to the axis of the instrument. This mirror throws all the reflected rays normally on the surface of the axial boiler. The larger mirror outside and the smaller mirror inside of this one throw their reflected rays inclined at small angles to the normal. Taking all the reflected rays together their mean normal component is 94 per cent. of the total reflected rays. It is therefore legitimate to increase the above figures in the proportion of 94 : 100, giving 0·93 horse-power or 9700 gr.° C. per square metre per minute. The mirrors are not perfectly reflecting, nor is the blackened surface of the boiler perfectly absorbing. An allowance of 7 per cent. for these deficiencies will not be thought extravagant, and we have in round numbers the work-value of the sun's vertical rays on the surface of the earth at or near the sea-level as 1 horse-power per square metre; the equivalent of this in heat is 10,300 gr.° C. per square metre per minute, or 1·03 gr.° C. taking the square centimetre as unit of area.

Mr. Michie Smith informs the writer that the highest rate which he has observed is 1·754 c.c. distilled per minute at a height of 7000 feet above the sea. This is exactly seven-sixths of the maximum rate observed on the banks of the Nile. If we imagine that in the most favourable circumstances the radiation as determined in Egypt might be improved in this proportion we get 1·17 horse-power per square metre and 1·202 gr.° C. per square centimetre per minute as a value of the heating power of the sun at the sea-level, which is probably very near the truth.

Comparing these results with those already quoted, we see that they agree with Crova's summer values as determined at Montpelier and lie midway between Vallot's (1891) values for Mont Blanc and Chamonix. We arrive therefore at the conclusion that the rate at which the surface of the earth at the level of the sea receives heat in the most favourable circumstances from the vertical sun is 1·2 gr.° C. per square centimetre per minute, or 1·17 horse-power per square metre. In discussing questions of terrestrial physics it would not be prudent to postulate a more abundant supply.

If we ascribe to the atmosphere a coefficient of transmission no greater than two-thirds, the value of the *solar constant*, or the heating power which the sun's rays would exert on a surface of one square centimetre exposed to them for one minute at a point on the earth's orbit, is 1·8 gr.° C. As the transmission coefficient is probably greater than two-thirds, the value of the solar constant is probably less than 1·8. Vallot, by giving effect to the rate of absorption actually observed in the air separating his two stations, arrives at 1·7 gr.° C. as the most probable value. These values are in substantial agreement with the older ones, such as those of Herschel and Pouillet; but there is a feeling at present that not much weight is to be attached to these results, and much higher figures seem to be more readily accepted. In a recent work, "Strahlung und Temperatur der Sonne," p. 38, J. Scheiner sums up the discussion of this subject by giving 4 as the most probable value of the solar constant.

As we have seen, the heat which arrives at the sea-level has to support the temperature of the land and that of the sea; it has also to supply the energy for all the movements of the ocean; it has to warm and expand the air, and to furnish the latent heat represented by the aqueous vapour in the atmosphere, and it is mainly accountable for winds and storms. All this is maintained on less than 1·5 gr.° C. per square centimetre per minute. But when the above catalogue of functions has been repeated, there is nothing left to be accounted for. If the sun's rays enter at the top of the atmosphere with an intensity of 4 and come out at the bottom of it with an intensity of only 1·5, how is the loss to be accounted for? It represents nearly double the energy which reaches the sea-level and produces such far-reaching effects. If it really entered the atmosphere it must be still there, either as heat or as its equivalent. But we know that the air is not made appreciably warmer by it, and we see no mechanical manifestations which can in any way be put forward as an equivalent. We conclude therefore that there is no excess of heat of this order to be accounted for, consequently values of the solar constant of the order of 4 are exaggerated.

J. Y. BUCHANAN.

REFLEX ACTION AND INSTINCT.[1]

IN the Paris *Journal of Anatomy and Physiology* of 1869 there was reported by Robin an experiment on the body of a criminal whose head had been removed an hour previously, at the level of the fourth cervical vertebra. The skin around the nipple was scratched with the point of a scalpel. Immediately there ensued a series of rapid movements in the upper extremity which had been extended on the table. The hand was brought across the chest to the pit of the stomach, simultaneously with the semiflexion of the fore-arm and inward rotation of the arm, a movement of defence as it were.

Probably none of us have seen quite so impressive an illustration of reflex action as the above, but most of us have watched the experiment in which a frog, having been decapitated and a drop of acid having been applied to its skin, the foot of the same side is brought up to wipe away the acid, and if this foot be cut off, after some ineffectual efforts and a short period of hesitation, the same action will be performed by the foot on the opposite side. These symptoms of apparently purposive action on the part of a brainless body have always struck me as most strange.

Some four years ago I had the privilege of reading to you a paper on memory, from which I will now quote:—"When we attempt to acquire some new feat of manual dexterity, involving a series of combined muscular movements, such as a conjuring trick, we find that, when first attempted, each movement has to be thought out, and the whole is effected with difficulty. Every time that the process is repeated the action becomes more easy; each movement of the muscles involved follows its predecessor with greater readiness, and at last the trick becomes apparently one action, is performed without thought, and may be said to be automatic. The nerve structures involved have acquired a perfect memory of what is required of them; each takes up its part at the proper moment, and hands on in succession an intimation to its neighbour that it is time to transmit the expected impulse. Nerve centres have been educated. An organic memory has been established."

I went on to give instances in which, by frequent practice, actions had become so habitual as to take place on the application of the stimulus without the will of the individual, and even contrary to his wish. I gave as an illustration the story of the old soldier who was carrying a pie down the street, when some one mischievously crying "Attention!" down went the soldier's hands to his trousers seams, and down went his dinner in the mud.

Let us apply this effect of constant practice to the case in question. The frog has a smooth, soft skin, unprotected by hair or scales. His haunts are stagnant water which swarms with injurious insects and other enemies; or the banks of ponds and streams abounding in sticks and stubs. From the time when the first progressive tadpole protruded his incipient legs, the race of frogs has been brushing away irritating substances. The nerve cells of their spinal cords have established such relations that, whenever a sense of irritation is conveyed to sensory cells, motor cells in connection are brought into action, and a complicated muscular movement follows, without the necessity of the interference of the will.

We may compare the association of nerve cells in the spinal cord to a group of men highly drilled in particular evolutions. Each individual cell of the group maintains relations with others near it by some one or more of its many arms. Upon the receipt of the intimation through sensory nerves and cells that there is, something burning a particular portion o the frog's skin, motor

[1] A paper read before the Derby Medical Society by W. Benthall, M.B., on April 9, 1901

cells accustomed to act with these sensory cells send out messages to particular muscles. If the message is responded to, if the foot comes up and the offending particle is brushed away, the stimulus and the effort cease. If the stimulus still goes on, other cells which supply accessory muscles are called into play. If this effort to remove the offending matter is vain, and the irritation still goes on, the stimulus is passed on to other cells, which have in an emergency previously been in the habit of assisting; the stimulus thus travels to the opposite side of the spinal cord, and the other leg now comes up to the point required.

It is the effect of drill, of practice, in the forgotten past. I am aware that in making this statement I am assuming the inheritance of acquired powers—an assumption directly in opposition to the views of Weismann, who maintains that no powers acquired during the lifetime of the individual are transmitted to the progeny.

The development of the reflexes and instincts which we shall refer to will be seen to be of such importance to the maintenance of the life of the individual or to the procreation of its race; that the slow and gradual formation of nervous connections can probably be explained by the Weismann theory; but for our purposes to-night the assumption of the inheritance of acquired powers enormously increases the ease with which we can understand their development.

The idea of this paper is therefore that, as in the *individual*, constant habit causes in time such a free connection between nerve cells as to facilitate the passage from cell to cell of a particular stimulus until the action follows the stimulus automatically, so in the *race* a particular response to a particular stimulus has been repeated so often that the connection has become congenitally perfect, has become in fact what we know as a reflex. And, further, that the frequent repetition of particular actions under similar stimuli have so influenced the *intelligent* actions of the animal, that *they* also have become engrafted upon the nerve system, and recur under the influence of similar stimuli in an automatic manner; the result of these reactions of the intelligence to a particular stimulus being what we know as instincts.

The great advantage of a reflex is the certainty and usually the rapidity with which it acts. The response to the stimulus does not have to travel round through the brain. It takes a short cut. With imperfect reflexes the animal is at the mercy of its surroundings.

Nature does not pass imperfect work. The eye reflexes, for instance, have been developed by constant practice. If through their failure an animal were partially blinded, some self-constituted Factory Inspector in Nature's workshop would soon get on the blind side of that animal, and there would be no chance of its perpetuating its failings. If the cough reflex failed, some septic fly would quickly start a fatal pneumonia.

Assuming that all reflexes have been developed by practice, it follows that our own are not merely aids to the diagnosis of disease at the hands of the physician, but are now, or have been, of use in some period of our history.

A year or two ago, in the *British Medical Journal*, there was a very interesting description of the strength of the reflex grip of the newly-born infant, this being sufficient to maintain the weight of the child for some minutes while hanging from a stick. This the writer attributed to the necessities of a time before perambulators, when a child had to hang on for bare life to its mother's hair or clothes. The inward-turned feet of the newly-born child and the plantar reflex point to a time when the feet were used for climbing and for grasping.

Many of the superficial reflexes were probably developed to get rid of flies and other irritants which must constantly have troubled the naked body. The reflex action exhibited by the decapitated body, described at the commencement of this paper, was attributed by the observer to an attempt at self-defence. I think it was more probably an attempt at scratching, an act which was probably habitual in our hairy ancestors, as it is now in our poor relations at the Zoo—a movement, in fact, strictly analogous to the movement of the frog's foot incited by the irritation of the acid. To assume that there was an intention of defence in the action imports into the movement an element of consciousness for which in the absence of the brain we have no warrant; and this brings us to the question of instincts, which have been defined as reflex actions into which an element of consciousness has been imported.

I will endeavour to trace an ascending scale of instincts showing their dependence on reflex excitation. A newly-born infant has to be placed to the breast; it then seizes the nipple with its lips and sucks. There is little difference between the reflex action incited by the contact of the maternal nipple with the infant's mouth and the cough or sneeze reflex; both are complicated actions of many groups of muscles. In the one case, spasmodic; in the other, rhythmical. The young of the rabbit, born blind and helpless, nuzzles about till it finds a nipple, and then takes its hold. The lamb, calf, or fawn, guided by sight and smell, *seeks* its mother's teat. In each of these cases a stimulus is required, either of touch, sight, or smell. Without the stimulus the experiment fails.

Fawns are peculiarly precocious. From the first they show a tendency to couch and hide on the approach of danger. The following is an extraordinary instance of combination of maternal and infant instinct:—

"I have had frequent opportunities," says the "Naturalist in La Plata," "of observing the young from one to three days old of the *Cervus campestris*, the common deer of the Pampas, and the perfection of its instincts at that tender age seems very wonderful in a ruminant. When the doe with fawn is approached by a horseman, even when accompanied by dogs, she stands perfectly motionless, gazing fixedly at the enemy, the fawn motionless by her side; and suddenly, as if at a preconcerted signal, the fawn rushes away from her at its utmost speed, and going to a distance of 600 to 1000 yards, conceals itself in a hollow in the ground or among the long grass, lying down very close with neck stretched out horizontally, and will thus remain until sought by the dam. When very young it will allow itself to be taken, making no further effort to escape. After the fawn has run away, the doe still maintains her statuesque attitude, as if to await the onset; and when, and only when, the dogs are close upon her, she also rushes away, but invariably in a direction as nearly opposite to the fawn as possible. At first she runs slowly with a limping gait, and frequently pausing as if to entice her enemy on, like a partridge, duck, or plover when driven from its young; but as the dogs begin to press her more closely her speed increases, becoming greater the further she succeeds in leading them from the starting point."

In considering this case we have to remember that the deer is, as a rule, a woodland animal, and that its fawn, while feeble, crouches under cover, of which there is plenty within immediate reach; but the deer of the Pampas lives on rolling prairies where the only cover is the isolated tufts of Pampas grass. While, therefore, the instinct to crouch is sufficient for the fawns of most deer, crouching in the immediate neighbourhood of the surprise would be useless in the open ground of the Pampas; and this artful combination of tactics has doubtless been developed by practice.

In birds we get even more marked differences in connate powers and instincts, from the naked young of the sparrow, which is nearly as helpless as the human baby, to the newly-hatched chicken, which is a regular little man-about-town at once. The habits of the latter have been closely studied. Hatched out in an incubator, and deprived of all maternal instruction and example, he quickly begins to peck at all small objects, with a preference for moving ones, and from the first shows an almost perfect power of estimating distance and direction, which is very marvellous when we consider the great number of muscles which have to be co-ordinated in the act.

The late Mr. Douglas Spalding placed beyond question the view that all the supposed examples of instincts may be nothing more than cases of rapid learning, imitation, or instruction, but also proved that a young bird comes into the world with an amount and a nicety of ancestral knowledge that is highly astonishing. Thus speaking of chickens which he liberated from the egg and hooded before their eyes had been able to perform any act of vision, he says that on removing the hood, after a period varying from one to three days, "almost invariably they seemed a little stunned by the light, remained motionless for several minutes, and continued for some time less active than before they were unhooded. Their behaviour was, however, in every case conclusive against the theory that the perceptions of distance and direction by the eye are the result of experience or of associations formed in the history of each individual life. Often, at the end of two minutes, they followed with their eyes the movements of crawling insects, turning their heads with all the precision of an old fowl. In from two to fifteen minutes they pecked at some speck or insect, showing not merely an instinctive perception of distance, but an original ability to judge and to measure distance with something like infallible accuracy. A chicken was unhooded when nearly three days old. For six minutes it sat chirping and looking about it; at the end of that time it followed with its head and eyes the movements of a fly twelve inches distant, at twelve minutes it made a peck at its own toes, and the next instant it made a vigorous dart at the fly, which had come within reach of its neck, and seized and swallowed it at the first stroke; for seven minutes more it sat calling and looking about it. For about thirty minutes more it sat on the spot where its eyes had been unveiled without attempting to walk a step. It was then placed on rough ground within sight and call of a hen with a brood of about its own age. After standing chirping for about a minute, it started off towards the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after life. It never required to knock its head against a stone to discover that there was no road there. It leaped over the smaller obstacles that lay in its path and ran round the larger, reaching the mother in as straight a line as the nature of the ground would permit. This, let it be remembered, was the first time it had ever walked by sight."

In this experiment each movement of the chicken appears to have been started by an external stimulus. It pecked at the flies which it saw. It jumped or evaded the objects which it saw in its path. It remained stationary until its hereditary tendencies were stimulated by the sound and sight of the old hen in its neighbourhood.

Mr. Spalding again says:—"The art of scraping in search of food, which, if anything, might be acquired by imitation, is nevertheless another indubitable instinct. Without any opportunities of imitation, when kept quite isolated from their kind, chickens began to scrape when from two to six days old. Generally the condition of the ground was suggestive, but I have several times seen the first attempt, which consisted of a sort of nervous dance, made on a smooth table." Mr. Spalding, however, does not seem to have seen them scrape unless the ground was suggestive, and Dr. Allen Thompson hatched out some chickens on a carpet where he kept them for several days. They showed no inclination to scrape because the stimulus applied to their feet was of too novel a character to call into action their hereditary instinct; but when Dr. Thompson sprinkled a little gravel on the carpet and so supplied the appropriate or customary stimulus, the chickens immediately began their scraping movements. Here, again, we see the hereditary instinct requiring a local stimulus to bring it about.

Mr. Spalding again says:—"A young turkey, which I had adopted when chirping within the uncracked shell, was on the morning of the tenth day of its life eating a comfortable breakfast from my hand, when the young hawk in a cupboard ust behind us gave a shrill chip, chip, chip. Like an arrow the poor turkey shot to the other side of the room, stood there motionless and dumb with fear, until the hawk gave a second cry, when it darted out at the open door right to the extreme end of the passage, and there, silent and crouched in a corner, remained for ten minutes. Several times during the course of that day it again heard these alarming sounds, and in every instance with similar manifestations of fear." Generations of young turkeys must in their native home have had cause to dread the cry of birds of prey; and the hereditary lesson had been well learned.

A water-bird was reared from the egg by another observer. It would swim freely, but he could not get it to dive by any means which he tried. One day while watching it in the water, a dog suddenly appeared on the bank. The necessary stimulus was applied; the hereditary reflex was set in action, and in the twinkling of an eye the bird had dived.

Handed down from generation to generation as these instincts have been, and impressed upon their owners by the imperative law that failure to inherit an instinct or a reflex meant death to the degenerate, these reactions persist long after they have failed to be of use.

As Dr. Louis Robinson has pointed out, the horse roamed, in a wild state, over plains of more or less long grass and low bushes. When a horse is alarmed, he throws up his head to get as wide a view as possible. The cow on the other hand keeps her head low, as if to peer under the boughs which covered the marshy grass of her jungle home. The horse's chief danger lay when, as he approached a stream to drink, he was liable to be sprung upon by a lurking lion; and to this day the two things that a horse dreads most are the rustling in bushes or reeds by the road-side and the wheelbarrow or tree-stump which his imagination depicts as a crouching enemy.

The dog once formed his lair in rough stuff, and now, when approaching sleep gives the accustomed stimulus, our pet dogs turn round three times upon the hearthrug to smooth down imaginary grass stubs. As an instance of an instinct which by its persistence under altered circumstances has become actually prejudicial, I may give the case of some shore-birds which had for many years nested upon flats covered with pebbles. As long as the pebbles remained, the eggs, which closely resembled them in markings, were rendered inconspicuous, but as the sea receded and grass grew, the pebbles became few and far between. The birds still, however, kept to their haunt, and actually collected pebbles around their eggs, thereby rendering their nests the more conspicuous.

In domestic fowls the habit of cackling as soon as they have laid an egg would certainly be detrimental to a wild race, and Hudson makes some interesting remarks on the modified habit in a semiferal race. The Creolla fowls, descended through three hundred years from the fowls introduced by the early settlers in La Plata, are much persecuted by foxes, skunks, &c., ever on the look-out for their eggs or themselves. These fowls in summer always lived in small parties, each party composed of one cock and as many hens as he could collect—usually three or four. Each family occupied its own feeding-ground, where it would pass a greater portion of each day. The hen would nest at a considerable distance from the feeding-ground, sometimes as far as four or five hundred yards away.

After laying an egg she would quit the nest, not walking from it as other fowls do, but flying, the flight extending to a distance of from fifteen to about fifty yards; after which, still keeping silence, she would walk or run, until, arrived at the feeding-ground, she would begin to cackle. At once the cock, if within hearing, would utter a responsive cackle, whereupon she would run to him and cackle no more. Frequently the cackling call-note would not be uttered more than two or three times, sometimes only once, and in a much lower tone than in fowls of other breeds. If we may assume that these fowls in their long semi-independent existence in La Plata have reverted to the original instincts of the wild *Gallus bankiva*, we can see how advantageous the cackling instinct must be in enabling the hen in dense tropical jungles to rejoin the flock after laying an egg, while if there are egg-eating animals in the jungle intelligent enough to discover the meaning of such a short subdued cackle, they would still be unable to find the nest by going back on the bird's scent, since she flies from the nest in the first place! It is obvious that while this form of cackling is useful, excessive cackling would in a state of nature lead to its own suppression.

We may suppose that as the wild fowl became more and more closely domesticated the eggs of the greater cacklers were more rapidly found and preserved by their mistresses, and this tended to increase the tendency to cackle; while in the half-wild fowls of settlers who had plenty to do besides looking after their poultry, there was a gradual reversion to the wild type by the elimination of the eggs of loud cacklers when not rapidly retrieved.

Birds which nest within a short distance of the ground display, as a rule, great skill in concealing their nests, and are very conservative in type. How is it that one chaffinch's nest is so like another's?

Gregarious birds like rooks have opportunities for learning by imitation, and may thus have lost some of their spontaneous skill. I have read somewhere that, when rooks were introduced into the Antipodes, young birds having been selected for transportation, they were found, when the breeding season came round, to be at fault, and finally imitated the nest of some native bird; but chaffinches build apart from one another; how, then, do they get their nests so nearly alike? A great observer has suggested that this is due to recollection on the part of the nesting pair of the home in which they were reared. This explanation does not commend itself to my mind, and is refuted, if not by the instance of the rooks just quoted, by the fact that tame canaries hatched in a nest of felt will, when they themselves breed, use moss for the foundation of their nest, and hair as a lining, just as a wild bird would do, although, as they build in a box, the hair alone would be sufficient.

If you want examples of what pure instinct can do, go to the insect world. There you get them in infinite variety. Hatched from the egg long after the death of the mother, the majority of insects have to depend entirely on the duly ordered reaction of their nervous organisms to stimuli similar to those which have for ages incited their forerunners.

The bot of horses has been hatched from the egg inside the stomach of its host. After some nine months' residence in the intestines, it is passed with the fæces and subsequently becomes the bot-fly. Until it becomes a perfect insect it has never seen the outside of a horse, and yet, as soon as it sees one, it knows exactly where to deposit its eggs in a position from which they can be licked off and swallowed in their turn. The sight and perhaps the smell of the horse is sufficient to inspire the hereditary desire to deposit eggs in a particular spot. If the stimulus and its reaction were insufficient, that particular bot-fly would cease to propagate.

The garden spider, again, hatched from an egg laid the previous autumn, brings an enormous amount of hereditary skill into the vicissitudes of its life. It selects its site, builds its web, adapts it according to the most approved plans to fortuitous circumstances, and distinguishes between harmless flies and dangerous wasps with an innate cunning which is an exact replica of the actions of the last year's brood. The nest of the trapdoor spider, too, is quite as wonderful a production as the nest of any bird.

Caterpillars, when they have reached their full growth, display great skill in selecting appropriate hiding places in which to pass into the chrysalis form, and those which weave cocoons do so in recognised stages. Huber has described one which makes, by a succession of processes, a very complicated hammock for its metamorphosis; and he found that if he took a caterpillar which had completed its hammock up to say the sixth stage of construction, and put it into a hammock completed only to the third stage, the caterpillar did not seem puzzled, but completed the fourth, fifth, and sixth stages of construction. If, however, a caterpillar were taken out of a hammock made up, for instance, to the third stage, and put into one finished up to the ninth stage, so that much of its work was done for it, far from feeling the benefit of this, it was much embarrassed, and forced even to go over the already finished work, starting from the third stage which it had left off at, before it could complete its hammock. In this experiment it would appear that each instinctive action calls other actions in definite order, and unless the proper sequence is maintained the intelligence of the insect is unequal to bridging the gap.

Now let us apply the facts and inferences aforesaid to the nesting of the chaffinch. We have seen how habits acquired during the life-time of the individual impress themselves upon the nervous connections, until, when the accustomed stimulus is applied, they become quite independent of the will. We have seen how certain reflex phenomena which are necessary for the life of the individual have, through congenital connections, become so automatic, that they take place whether the brain is present or not. We have seen how habits of wild animals have, through similar nervous bonds, been handed down to tame descendants long after the said habits were useless and even detrimental. We have noted that ancestral habits may lie in abeyance until some perhaps unexpected stimulus arouses them—for instance, the scraping of chickens when placed upon gravel, or the diving of a water-bird upon sudden fright. We have ascertained that many of these instincts are certainly not due to instruction by older animals, but are purely spontaneous; that in insects these spontaneous actions are often most complicated, and are sometimes *not only* carried out in definite order, as in the weaving of their cocoons, but *cannot* be carried out except in that definite order.

The inference I draw is that the nest-building of the chaffinch is due to a succession of reflexes. You remember that when Alice was wandering about in Wonderland, she was continually coming upon medicine-bottles, marked "Drink me," or upon pieces of cake, marked "Eat me." You remember that when Alice obeyed these directions strange things happened. Alice was able to decipher her labels by the result of long and painful study in her nursery. Had they been written in the Cuneiform character, though perhaps perfectly intelligible to another, they would have conveyed nothing to her. The nervous system of the chaffinch has been educated by generations of hereditary experiences, and when the newly-wedded chaffinch pair start upon their housekeeping, they see in their mind's eye, upon some suitable site, a label marked "Build here"; they go through the stages of their architecture much as the caterpillar spins the different stages of its cocoon, each stage suggesting its successor; and each twig, hair, or feather which they use, bears upon it a label, "Use me next."

THE EDUCATION OF ENGINEERS.

SEVERAL papers on the training of engineers have recently come under our notice, and it seems worth while to bring together some of the expressions of views upon this important subject. It is difficult, if not impossible, to lay down any hard and fast line as to the course to be adopted by a youth who wishes to become a qualified engineer, for the way to follow must depend largely upon the position, age, prepotency and previous training of the aspirant. Assuming, however, that the principles of science have been studied at school, with practice in the physical laboratory, the question is, what is the next step to be taken? The answers to this are many and various, as will be gathered from the following notes from recent papers on the subject.

A paper on the training of electrical engineers, read by Dr. J. T. Nicolson before the Manchester section of the Institution of Electrical Engineers and published in the *Journal* of the Institution (May 1901, No. 150), with the discussion upon it, contains some noteworthy statements. The province of the laboratory in the scheme of electrical engineering is, Dr. Nicolson remarks, first to extend scientific knowledge by providing more experimental data; secondly, to show the student the scope, value and limitations of the theories he has studied in the class-room; and thirdly, to provide object-lessons on the general trend of electrical engineering design by means of machines and instruments of the newest types procurable.

Theory must not, however, be neglected. "Resting on a strong foundation of mathematics, physics and chemistry, the knowledge of the engineer must always include such pure sciences as those of kinematics, dynamics, hydrodynamics, thermodynamics and electrodynamics. A sound elementary acquaintance with all of these is necessary, and a specialised knowledge of that one more particularly useful to the engineer in his own branch must be obtained. It is, for instance, quite hopeless to try to explain to a man who has no knowledge of dynamics, upon what principles one proceeds in endeavouring to balance a locomotive. No amount of laboratory experiment will enable him to dispense with a knowledge of the mechanical principles involved. Again, the fundamental principles of thermodynamics may not be of much use in helping a man to fix the size of the cylinders of a steam engine; but they will, at all events, keep him from wasting his time in trying to design a perpetual-motion machine, and they will show him how far he can hope to go in the direction of the improvement of his heat motors, or other energy transformers." As Prof. Perry has said:—"An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things."

This latter qualification, a knowledge of theory, he must acquire by private study and from his college lectures; the former will be best inculcated by experimental work in the laboratory. In the electrical profession, considerable difference of opinion exists concerning the stage at which a youth should enter the works, if he is free to choose. Dr. Nicolson holds strongly the opinion that, after leaving school, the boy who intends to become an electrical engineer should first spend at least two years in the workshops of a *mechanical engineer*. Here he will learn the elements of smithing, moulding, pattern-making, fitting, machine-work and erecting. In this time he cannot help picking up the names and appearance of the common implements and processes fundamental to all kinds of engineering practice. Having put in two years in a mechanical engineering workshop, Dr. Nicolson thinks the student ought to enter an engineering college at about the age of eighteen, and he ought to study there for not less than three years.

"This last portion of his laboratory time should be devoted by our embryo electrical engineer to what is, in America, called 'thesis' work. This is of the nature of an experimental research, carried out either by the student himself or by a small group of students of which he is one. Very much valuable information has been obtained in American colleges in this way, regarding the various types of new apparatus continually coming out; and it is found that the students learn, in the course of such work, to assume responsibility by being in a large measure left to their resources. Such investigation usually requires either special apparatus or the loan of new types of machinery; but good work may also be got by making progressive tests of an operating plant either in the college or elsewhere."

In the discussion upon Dr. Nicolson's paper, the view that an interval between school and college should be passed in an engineering works was not generally accepted. In the opinion of most speakers, it is better for a youth to go straight from school to a technical college for three years, and to obtain workshop experience after the college training, than to enter works at once. Dr. E. Hopkinson pointed out that for a boy to leave school at about the age of sixteen, and to enter a workshop with the idea of returning to school or college after an interval of two or three years involves a break in the scholastic course, and in habits of learning, which often has disastrous results. The best men are usually those who have had a continuous school and college career up to twenty-two or twenty-three years of age.

Another plan proposed is a combination of the half factory and half technical school, and this system is now under the consideration of the Manchester Association of Engineers. Mr. M. P. Higgins advocates the establishment of schools of this kind in an article in the August number of *Feilden's Magazine*. Such a school should, he says, possess the following features:—(1) a first-class commercially successful and productive machine-shop, which is a department coordinate in importance, influence and educational value with the academic department; (2) the pupils to be given instruction and practice in this shop during half the working hours in five days of each week, for a period of four years; (3) instruction in the public schools to be given during a portion of the other half of the time, equivalent to a high-school course, restricted, abridged and improved to meet the needs of these pupils; (4) special care and method of selection of pupils who have finished the grammar-school course and who have special aptitude for mechanical work; (5) management under a corporation whose trustees shall be practical business men.

If technical colleges were equipped with ordinary commercial apparatus and machines and kept in complete touch with engineering advances, much of the difficulty as to training would be removed, for students at such colleges would be able to combine the realities of the workshop with the theoretical instruction. But, as Dr. Nicolson pointed out in his paper, the data available in an engineering school are seldom of the latest, unless the teacher spends his summer in obtaining them. The instructor in electrical engineering has the special difficulty of the newness and constant development of his subject to contend with; but if he follows the practice of every year visiting the plants of the manufacturing companies and typical light and power stations, information is obtained which cannot be found in engineering literature and which has the highest value for educational purposes. The cultivation of close relations between the college and the practising profession should, indeed, be part of the duty of instructors and ought to be eagerly reciprocated by the working engineers as one of the surest ways of meeting foreign competition.

The closer sympathy between science and industry is, indeed, probably the most important factor to be considered. Engineers should see that technical colleges are brought into contact with current work, and arrangements might be made whereby young men from works could be sent from works to the laboratories of scientific institutions to carry on researches for the benefit of the firms employing them. This system is already partly in vogue in Germany and America, and has produced very gratifying results.

This summary of opinion may appropriately be concluded with some extracts from an article on the engineer of the twentieth century, by Prof. V. C. Alderson, Dean of the Armour Institute of Technology, Chicago.

"In the realm of mathematics the training of the engineer will be most rigid and exact. He will cut loose from the idealistic, academic mathematics, as the student of higher literature will cut loose from mere grammars. His mathematics must run down through his fingers, as it were. Mere juggling with symbols will be useless to him. He must regard his mathematics as one of his tools, as a means to an end, or as a language in which to express his thoughts. The future engineer may be successful if his training has included a greater or less amount of shop practice with perhaps indifferent laboratory instruction and a meagre equipment, but no engineer can be broadly successful and thoroughly competent without a deep and exhaustive theoretical treatment of engineering subjects. This does away with the common opinion that literature and books are not essential to the engineer's success, for the next quarter of a century will see the engineering profession rise to the dignity of the older professions.

"The conditions which will beset the engineer of the twentieth century will be exacting beyond anything we now know. The importance of a strong foundation in scientific principles cannot be over-estimated, for scientific principles are only the laws of nature. These principles cannot be learned readily after a man has begun his life work. His whole energy will then be devoted to applying these principles correctly, not in acquiring them laboriously. It will be a prime necessity for the technical college of the future to lay these foundations broad and deep. It will be regarded as a weakness for a college to teach its students only the knacks of the profession, only just enough to be an ordinary draughtsman, a tolerable surveyor, or first-class linesman.

"The technical graduate of the twentieth century will be marked by certain characteristics which are too rarely found in men trained in the colleges of literature and arts. Among these are directness of purpose, intellectual accuracy and clear thinking. The student of science and technology is trained in the realm of realities, where to commit error, to act without purpose, or to think vaguely are seen at once to be fruitful of harm. Economic and industrial needs will bring education from the cloistered lecture-room into the open air of the laboratory. Technical education will have a practical, helpful bearing upon the problems of life. No longer will the seclusion of the scholar be a mark of honour. Education will be found at the bench, by the forge, in the shop, the laboratory and the drafting-room, as well as in the library. The lesson to be taught will be how to apply scientific ideas to the solution of problems actually arising in the struggle to bring the forces of nature under the sway of man.

"As technical education develops, questions of far-reaching importance must be settled. Probably the most important will be the decision as to what kind of man shall guide the technical college. In law, medical and theological schools, the lawyer, the doctor and the minister, respectively, hold first place and have much to say both in the actual training and in the management of the schools. Prominent members of the profession direct the destinies of the schools. To a much less extent do practising engineers influence the technical schools.

"The engineering college represents that form of scientific education most suitable to the exacting demands of advancing civilisation. The particular form of education which it gives through shop and laboratory practice, through practical tests, through acquaintance with the needs of industry, must not and will not be retarded by the classic heirlooms of the literary college. The engineering college must fill its own niche and work out its own salvation. Technical education is an educational and not an engineering problem.

"The technical college in which the future engineer is to be trained has several important characteristics to maintain. First, to educate scientifically and technically those who shall lead the march of the coming civilisation in industrial lines; second, to educate the public to a true sense of the value of applying scientific principles to industrial processes; third, as the university has for one of its functions the extension of human knowledge in any and all lines, so the technical colleges will recognise that the investigation of questions relating to applied science is within its own sphere of usefulness. Probably no investigation to-day would be more fruitful of good results to the engineering profession and to the public at large than the systematic study and thorough test of materials of construction. Such an investigation done on a large scale, on specimens of full building size, in a scientific manner, would save millions of dollars and put the science of construction on a scientific and economic basis. While the university asks no questions about the usefulness of the information gathered within its walls, the technical college must make its investigations in fields that are distinctly useful."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LORD AVEBURY referred to the neglect of scientific education in secondary schools, in an address delivered at Nottingham on Tuesday, before the Association of Chambers of Commerce of the United Kingdom. He pointed out that the public schools are legally bound, by the regulations made by Lord Salisbury's Royal Commission, to give in all examinations one-eighth of the marks for mathematics, one-eighth for modern languages, and one-eighth for science. How science fares may be judged by the fact that one public school with 900 boys has four science masters, and another with 500 boys only has three. In fact, the complaint made long ago by Ascham and Milton, and reiterated by Royal Commission after Royal Commission, still holds good to a great extent.

THE following list of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (Science), 1901, has been issued by the Board of Education, South Kensington:—*Royal Exhibitions.*—Walter Smith, Henry F. C. Walsworth, Alec J. Simpson, James C. Smail, John Good, Sydney F. Paul, George E. Piper. *National Scholarships for Mechanics.*—George W. Phillips, Alfred W. Steed, David P. Grubb, Thomas G. John, Henry J. Jones. *Free Studentships for Mechanics.*—Herbert G. Tisdall, Thomas Chester. *National Scholarships for Physics.*—George W. Andrew, Leonard Southerns, John B. Homer, Sydney H. Higgins, Roger E. Grime. *Free Studentship for Physics.*—Otmar U. Seeman. *National Scholarships for Chemistry.*—Herbert B. P. Humphries, Alfred Shepherd, Alfred Berry, Donald Levy, Sydney H. Smith. *Free Studentships for Chemistry.*—Joseph A. Stokes, John F. Stansfield. *National Scholarships for Biology.*—Arthur R. Mynott, Alfred Eastwood, Richard C. Bristow, Malcolm Wilson. *Free Studentship for Biology.*—Florence E. Pratt. *National Scholarships for Geology.*—John E. Haworth, Claude G. Sara, Tobias Clegg.

THE candidates successful in the recent competition for the Whitworth Scholarships and Exhibitions are announced by the Board of Education, South Kensington, to be as follows:—Scholarships, 125*l.* a year each (tenable for three years)—Charles E. Handy, John E. Jagger, Albert Wilson, James C. Macfarlane. Exhibitions, 50*l.* (tenable for one year):—Thomas P. Shilston, Arthur Baker, George W. Phillips, George H. Andrews, John S. Nicholson, Henry F. C. Walsworth, Thomas G. John, Harry J. Wickham, John Good, James C. Smail, Gilmour E. Brown, George E. Piper, Alexander Gray, Arthur H. Sturdee, Harry Topham, Reginald Lavender, William H. Snow, Richard F. Barber, Harold Scragg, Harold E. Morrow, Thornton Knowles, John Ingham, Percy M. Bennett, Ernest G. Beck, Alfred G. Fox, Harold Fowler, Frank Lord, Thomas Chester, William E. Gardner, Roland W. Parry.

FROM particulars given in the thirteenth annual report just published by the National Association for the Promotion of Technical and Secondary Education, it appears that considerably over a quarter of a million of money (or 286,980*l.*) has become involved during the past year for the structural development of technical schools in England. If this sum be added to the trustworthy estimate of 2,643,172*l.* given in last year's report, it shows that the total amount incurred in England (excluding London) for 295 schools under municipal and public bodies is now at least 2,930,152*l.*; if all outlays upon other schools could be definitely assessed, this sum would doubtless reach more than 3,000,000*l.* (excluding London). The largest of the new building schemes is that of Bolton, the estimated capital outlay being 80,000*l.* The school will be established to a considerable degree upon Continental models, and will form one of the most important centres of technological training in the country. In Liverpool, 14,500*l.* is to be utilised for the equipment of a central technical school costing over 100,000*l.*; an important movement towards centralisation is consequently now taking place in that city.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 26.—M. Bouquet de la Grye in the chair.—Remarks by M. Janssen upon some observations of the Perseids from the Observatory at the summit of Mont Blanc.—On the application of the principle of energy to electrodynamic and electromagnetic phenomena, by M. E. Sarrau.—Critical remarks concerning the determination of sex in the Lepidoptera, by M. Alfred Giard. In discussing the results of the experiments of M. C. Flammarion upon the influence of colours in the production of the sexes in *Sericara mori*, the author points out certain morphological data which modify the interpretation of the experiments considerably. In the opinion of the author, the great error of physiologists in studying questions of this order, as in many others, is in completely neglecting the morphological data, and in considering the animal or vegetable egg as a point of absolute departure, instead of a complex of energies accumulated by the varied conditions of existence or found in the ancestral organism.—On the mode of action of the brakes of automobiles, by M. A. Petot. From the formulæ usually employed to express the relation between the inertia and the co-efficient of adherence it can be deduced that it ought to be impossible to stop an electric tramway as rapidly as another vehicle, under similar conditions of speed and adherence. It is shown in the present note that this is an error, due to an inexact interpretation of the function of adherence during the application of the brake.—On the constitution of white light, by M. O. M. Corbino. According to M. Gouy, the different rays constituting the spectrum of white light are sinusoidal and perfectly regular components of one single complex vibration of any form whatever, and hence it follows that these components, their amplitude and phase remaining invariable, can interfere. According to M. Carvallo, the radiations separated by a grating are independent and consequently cannot interfere with each other. According to the author, the production of a system of mobile fringes in a channeled spectrum affords a crucial test of these two views. From these it is concluded that two radiations taken from different points of a continuous spectrum produced by white light are completely independent, and that in consequence it is impossible to consider them as two sinusoidal components of a single complex vibration.—The sexual elements and copulation in Stylorhynchus, by M. Louis Léger.—On a bacterial disease of the potato, by M. G. Delacroix. The disease in question, which is very prevalent in the centre and west of France, is due to a bacterium which appears to be identical with the *Bacillus Solanacearum* of E. F. Smith. It possesses the same characteristics on cultivation, and the symptoms of the disease observed in the United States on potatoes and tomatoes are similar to those observed in France. The only suggestion that can be put forward as a remedy is a triennial variation in the crops in order to clean the soil, which appears to be the vehicle of the disease, from the pathogenic organisms which it contains.—The invasion of streams of water in the department of Herault by *Jussiaea grandiflora*, and on the growth of this species in France, by M. P. Carles. The growth of this plant in some districts is so great that it forms true aquatic prairies. It has been stated that this plant could not fructify in France, but this is now shown to be inaccurate, since in the month of September on the River Orb the fruit was formed in the shape of capsules about 29 mm. in length, each capsule having five divisions containing about fifteen seeds. It is by these seeds that it multiplies so abundantly.

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