cynosurus) from West Africa, two Victoria Crowned Pigeons (*Goura victoriæ*) from the Island of Jobie, deposited; three Ruddy Flamingoes (*Phœnicopterus ruber*) from North America, purchased; two Ring-tailed Lemurs (*Lemur catta*), a Great Kangaroo (*Macropus giganteus* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN

ASTRONOMICAL PHOTOGRAPHY.—M. Mouchez, the Director of the Observatory of Paris, has communicated to the Academy of Sciences a brief account of some experimental attempts to photograph very small stars, which have been lately made at that establishment. The ecliptical star-charts, commenced by Chacornac, but interrupted in their formation by his decease, were taken up by MM. Paul and Prosper Henry in 1872. These charts include all stars to the thirteenth magnitude; thirty-six of the entire number of seventy-two required for the whole ecliptical zone were completed by Chacornac; these contain 60,000 stars; while sixteen more, containing 36,000 stars, have been constructed by MM. Henry, who will shortly finish four others, with 15,000 stars. But they now find themselves in face of a difficulty which can hardly be overcome by the ordinary process of charting. The condensation of stars in those regions where the Galaxy traverses the ecliptic is so great as apparently to defy an accurate and complete representation of their stellar contents, on the methods adopted for the greater part of the zone, notwithstanding all the experience and well-known skill of the observers.

They have accordingly had recourse to photography, and their first attempts with a provisional apparatus have succeeded so well that there is every reason to expect by this means a solution of the difficulty in question. On plates covering an extent of 3° in right ascension and 2° in declination, obtained with an objective of 0·16 m. diameter and 2·10 m. focal distance, achromatised for the chemical rays—which M. Mouchez exhibited to the Academy—there are shown some 1500 stars from the sixth to the twelfth magnitude, *i.e.* to the limit of visibility of an objective of that size; the images of the stars have diameters nearly proportional to their brightness, except in the case of the yellow stars, which come out somewhat fainter. These encouraging results have led MM. Henry to commence the construction of a large objective of 0·34 m. diameter, which will be mounted by M. Gautier, and it is anticipated that with this instrument, in the course of an hour, a chart of the stars, to the twelfth magnitude at least, and probably to the thirteenth or fourteenth, of the same dimensions as one of the published charts, will be obtained; a work which would otherwise require many months of assiduous labour.

THE BRITISH ASSOCIATION CATALOGUE OF STARS.—In a book-list circulated during the last week by a Dresden firm, a copy of this Catalogue has a price of 200 marks (10*l.*) attached, excused by the addition, "Aeusserst selten." As regards star-places the volume is out of date, and the same may be said of the so-called constants for reduction of mean to apparent positions, if any degree of accuracy be required; but it is nevertheless still sought after, especially by those who are commencing the study of astronomy, as will be well known to every one who has any pretence to be considered a practical authority; and it must be admitted that, for purposes of identification and for synonyms in some of the principal older catalogues, the B.A.C. has still its uses. The question arises, whether there would not be a considerable demand for a new general Catalogue of the principal stars, or of stars to the limit of naked-eye vision, brought up from the best authorities to, say, the epoch 1900, but unencumbered with the reduction-quantities, which would materially diminish the expense of formation. A Catalogue of this description, we take it, is not likely to be again provided from the funds of such a body as the British Association, and perhaps the most feasible method of producing it would be by way of subscription. One difficulty would no doubt consist in securing a supervisor of the plan and formation of the work;—perhaps few competent persons could be named who have the leisure which Baily fortunately possessed, and to which we owe not only the B.A.C. but the Catalogues of Lalande and Lacaille.

THE COMET 1884*b*.—Prof. Krueger's telegram to Melbourne led to the observation of this comet, both by Mr. Ellery and Mr. Tebbutt on July 24. Mr. Tebbutt sends us several letters which he has addressed to the *Sydney Morning Herald*.

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee, consisting of Dr. Gladstone, F.R.S. (Secretary), Mr. William Shaen, Mr. Stephen Bourne, Miss Lydia Becker, Sir John Lubbock, Bart., M.P., F.R.S., Dr. H. W. Crosskey, Sir Henry E. Roscoe, F.R.S., Mr. James Heywood, F.R.S., and Prof. N. Story Maskelyne, M.P., F.R.S., for the Purpose of Continuing the Inquiries relating to the Teaching of Science in Elementary Schools.—Since the reappointment of your Committee at Southport no legislation affecting the teaching of science in elementary schools has taken place, and it is yet too early to estimate the whole influence of the Education Code of 1882 in that respect. Some indications, however, have been gathered from the Blue-book and from some of the large Boards. The first effect of the change of Code upon the teaching of science is shown in the return of the Education Department for this year; but as the tabulated statements only extend to August 31, 1883, they contain merely the results of those examinations that were made of schools which came under the new Code between April 1 and August 1, 1882, or about 28 per cent. of the whole. The following conclusions may be drawn: (1) Elementary science was taken up by scarcely any schools examined during these months, the number of departments that took it up as the second class subject being only 15, while 3988 took up geography, 1644 (girls) needlework, and 114 history. It must be remembered that geography is more scientific than it was before, but needlework is rapidly displacing it in girls' schools. (2) The exclusion of the Fourth Standard from instruction in specific subjects has reduced the number of scholars so taught by 56·6 per cent.; but the remaining 43·4 per cent., that is to say, the children in Standards V., VI., and VII., do receive a larger proportion of scientific teaching. The actual number of children examined during these four months in the mathematical and scientific specific subjects is given in Column I. of the following table; Column II. gives the estimated number who would have been examined under the old Code; Column III. the number of those who would have been above Standard IV.

Subject	Col. I.	Col. II.	Col. III.
Algebra	8,256	1,847	799
Euclid and Mensuration ...	604		
Mechanics, Scheme A ...	635	1,393	603
,, Scheme B ...	—		
Animal Physiology	7,078	8,537	3,696
Botany	1,020	642	278
Agriculture (principles of)...	422	—	—
Chemistry	368	—	—
Sound, Light, and Heat ...	196	—	—
Magnetism and Electricity...	1,133	—	—
Domestic Economy	6,090	16,890	7,232
Totals	25,802	29,309	12,608

Comparing Columns I. and II., it will be seen that the actua number examined in these subjects is not much less than would have been examined under the old Code, when the Fourth Standard was included; but the number of girls who have taken up domestic economy is 10,800 less. If we compare Column I. with Column III., which embraces the same Standards, it appears that double the number of children have passed in these mathematical and scientific subjects. This is, no doubt, mainly due to the fact that English literature and physical geography are removed to the category of class subjects. The great gain has evidently been to the study of algebra, that subject and Euclid being taken up by about eleven times as many as previously took up mathematics. Animal physiology and botany have also largely increased. Mechanics is about the same, while of the new subjects magnetism and electricity has proved itself the favourite, while agriculture, chemistry, and sound, light, and heat follow in order. The only subject that has actually lost ground is domestic economy, which is no longer obligatory in girls' schools if a specific subject is taken. The following table gives the number of passes in specific subjects made by the London School Board children in 1881–82, and in 1883–84. The second column gives the estimated number of those that were made in Standards above IV., corresponding to Column III. in the previous table.

Subject	1881-82 Standard IV. and upwards	1881-82 Over Standard IV.	1883-84
Algebra	213	101	3,113
Euclid and Mensuration ...			139
Mechanics	48	23	165
Animal Physiology	8,667	4,094	5,657
Botany	534	252	686
Agriculture (principles of) ...	—	—	299
Chemistry	—	—	198
Sound, Light, and Heat ...	—	—	179
Magnetism and Electricity...	—	—	825
Domestic Economy	9,597	4,533	3,478
Totals	19,059	9,003	14,739

The following information has been furnished from the Manchester School Board :—

I. Class subjects.

Departments	1882 Grammar	1882 Geography	1882 Needlework	1882 History	1883-84 English	1883-84 Geography	1883-84 Needlework
Boys	26	24	—	1	31	30	—
Girls	26	11	8	1	28	4	23
Junior... ...	13	10	—	—	21	13	3
Mixed ...	4	—	1	—	4	—	3
Totals ...	69	45	9	2	84	47	29

Historical and geographical readers are provided in every department, and even though the subject be not taken for the Government examination the children are always questioned on the matter of the reading-books by the Board's Inspector.

II. Specific subjects (scientific).

Subject	Departments 1882 Boys	1882 Girls	1884 Boys	1884 Girls
Algebra ... ... } Mathematics ...	4	—	13	1
Euclid and Mensuration ... ... } Mathematics ...			1	—
Mechanics	3	—	1	—
Animal Physiology	2	—	2	—
Botany	1	—	—	3
Domestic Economy	—	10	—	2
Totals	10	10	17	6

III. Science teaching under the Science and Art Department is given as follows :—

Subject	Departments Boys	Girls
Mathematics	3	2
Physiology	1	1
Chemistry	3	2
Sound, Light, and Heat	2	2
Magnetism	2	2
Totals	11	9

The Brighton School Board had the following number of children studying the specific subjects during the quarter ending March 25, 1884 :—

	Boys	Girls
Algebra	285	—
Euclid and Mensuration	13	—
Animal Physiology	292	6
Magnetism and Electricity	149	—
Domestic Economy...	—	261

As to class subjects, the ten boys' departments all take up geography as the second, the number of children under instruction being 2879; while only one girls' department, with 119 children, takes geography for the Government examination, though it is taught in most of the others through reading lessons. The other nine girls' departments, with 2339 children, take needlework as the second class subject. At the Southport meeting a recommendation was passed that this Committee "be requested to consider the desirableness of making representations to the Lords of the Committee of Her Majesty's Privy Council on Education in favour of aid being extended towards the fitting up of workshops in connection with elementary day schools or evening classes, and of making grants on the results of practical instruction in such workshops under suitable direction, and, if necessary, to communicate with the Council." As it was believed that the second Report of the Royal Commissioners on Technical Instruction would have an important bearing upon this question, the Committee was not called together till the publication of that Report. It was not issued till May, and it then appeared that, in addition to a very large amount of valuable information, the Royal Commissioners had recommended, among other things :—"(*b*) That there be only two class subjects instead of three in the lower division of elementary schools, and that the object lessons for teaching elementary science shall include the subject of geography." "(*d*) That proficiency in the use of tools for working in wood and iron be paid for as a specific subject, arrangements being made for the work being done, so far as practicable, out of school hours. That special grants be made to schools in aid of collections of natural objects, casts, drawings, &c., suitable for school museums." With reference to recommendation (*b*) your Committee, without expressing any opinion as to the desirability of forming one subject out of geography and elementary science, consider that, if this change be effected, the two class subjects which will then represent literature and science should stand upon an equal footing. This would be in accordance with the resolution of the Council passed on December 5, 1881, in considering the recommendations of your Committee in regard to the proposals for the new Code. At present, if only one class subject is taken, the Code requires that it should be "English" (grammar and literature); but many managers or teachers might prefer taking science. With respect to recommendation (*d*) your Committee thoroughly approve of the proposals, which, if carried out, would realise the wish expressed in the reference to them from the Southport meeting. They have not, however, thought it necessary to communicate at once with the Council, as there is no immediate legislation in prospect, and the meeting at Montreal might like to give further instructions on the subject. The name of Prof. N. Story Maskelyne, M.P., has been replaced on the Committee.

Report of the Committee, consisting of Sir Joseph Hooker, Dr. Günther, Mr. Howard Saunders, and Mr. P. L. Sclater (Secretary), appointed for the Purpose of Exploring Kilimanjaro and the Adjoining Mountains of Eastern Equatorial Africa.—(1) The Committee have the satisfaction of announcing that they have made arrangements with Mr. H. H. Johnston (who has recently returned from the Congo) to undertake an exploration of Kilimanjaro, and that he is probably by this time encamped upon that mountain. (2) The Committee have arranged with Mr. Johnston to undertake the cost of the expedition for 1000*l.*, without reference to personal remuneration. It is believed that the necessary expenditure will not be covered by this sum, but Mr. Johnston has agreed to make good any deficiency. (3) Towards this sum of 1000*l.* the Committee have appropriated a sum of 500*l.* granted to them by the Association at their last meeting at Southport. The Committee have also received from the Government Grant Committee of the Royal Society two sums of 250*l.* each, so that the whole sum of 1000*l.* required for the expedition is already available. (4) But looking forward to the risks of African travel, and to the expenditure likely to be incurred on the transport to this country, and on the working out of the collections obtained by Mr. Johnston, the Committee trust that a further sum of 50*l.* may be placed at their disposal. (5) A copy of part of Mr. Johnston's last letter to the Secretary of the Committee, containing an account of the progress of the expedition, is annexed to this Report.

Extracts from a letter from Mr. Johnston to Mr. Sclater, dated British Residency, Zanzibar, May 13, 1884 :—"At last my expedition, thanks to the help of Sir John Kirk, is organised and ready to start. I have engaged thirty-two men here (at Zanzibar), and have sent them off to Mombasa in a dow to await my coming. I myself leave to day for Mombasa in the mail. At Mombasa, through the Consul (Capt. Gissing), I have engaged sixty more men, for it will need nearly a hundred porters to carry my goods and baggage to Chagga. I hope to leave Mombasa in a fortnight's time. I anticipate three weeks' easy travel to Kilimanjaro, and, as far as it is possible to foretell aught in Africa, no serious difficulties seem to stand in my way. The expedition, however, will prove much more costly than I had anticipated. . . . However, I think I shall be able to make both ends meet for six months on Kilimanjaro, and if I stay longer, or make a dash at Kenia, it will be on my own account. I shall *probably* make Taita or Teita (*vide* map) a half-way house, and go backwards and forwards with collections and

goods. I shall try to forward collections addressed to you by *every mail* if feasible. Then, if you judge of the value, and estimate that my share of the collections will realise a good amount, it will induce me to devote more time to the country. My health, notwithstanding a much more trying climate than I have yet met with in Africa, has been very good, and I have not known an hour's illness or indisposition. Sir John Kirk has shown me the utmost kindness and hospitality, and his help and his influence have smoothed away many difficulties. The expedition promises most favourably, as the present condition of the countries to be traversed is good and peaceful, food abundant, and provisions cheap. . . . . I have obtained the services of three of Dr. Fischer's bird-skinners, and have got one botanical collector, trained under Sir John Kirk, and acquainted with the mysteries of 'soldering' and preserving in spirit. I have sent for rectified spirit from Bombay, and in the interval am using trade gin. The Sultan has given me three kegs of gunpowder to give as presents to chiefs, and has also furnished me with letters of introduction. I am in excellent condition, and start to-day on my journey in the best spirits and with the strongest hopes of its success."

Report of the Committee, consisting of Mr. James N. Shoolbred (Secretary) and Sir William Thomson, appointed for the Purpose of Reducing and Tabulating the Tidal Observations in the English Channel made with the Dover Tide-Gauge, and of Connecting them with Observations made on the French Coast.—The Committee beg to report that the tidal curves of the self-registering tide-gauge at Dover for the years 1880, 1881, 1882, and 1883, have been kindly placed at their disposal by the Board of Trade, for reduction and tabulation; and that the Belgian Government have been good enough to present to the Committee copies of the tidal curves at Ostend during the same period of four years. The reduction and tabulation of the high and low water registers of these two sets of tidal curves has progressed satisfactorily, and will be shortly completed. It is hoped also that a like reduction will be soon commenced with other self-registering tidal curves during the same period at several other points, both on the English and the French coasts. The Committee request to be allowed to transmit to the Board of Trade and to the Belgian Government respectively, the thanks of the Association for their assistance and donations in furtherance of this inquiry. The Committee request to be re-appointed, with a grant of 10*l.* to defray the expenses of reduction, &c.

Report of the Committee, consisting of Prof. Balfour Stewart (Secretary), Prof. Stokes, Mr. G. Johnstone Stoney, Prof. Roscoe, Prof. Schuster, Capt. Abney, and Mr. G. J. Symons, appointed for the Purpose of Considering the Best Methods of Recording the Direct Intensity of Solar Radiation.—This Committee, acting on a suggestion made by Gen. Strachey, have chiefly devoted their attention to the subject of a self-recording actinometer. The self-recording actinometer of Mr. Winstanley would not be suitable,[1] because it is influenced by radiation from all quarters. Other actinometers require manipulation on the part of the observer which would make it almost impossible to make them self-recording. It was suggested by Prof. Balfour Stewart that a modification of his actinometer might be adapted to self-registration by taking for the quantity to be observed, not the rise of temperature of the inclosed thermometer after exposure for a given time, but the excess of its temperature when continuously exposed over the temperature of the envelope. After making some calculations as to the behaviour of such an instrument, Prof. Stokes came to the following conclusions:—(1) The inclosure should be of such a nature as to change its temperature very slowly, and of such a material that the various portions of the interior should be at the same moment of the same uniform temperature. For this purpose an arrangement somewhat similar to that used in Prof. Stewart's actinometer is suggested; the outside to consist of polished metallic plates, then a layer of some non-conducting substance, such as felt, then a thick copper interior which need not be polished. Into this copper is to be inserted a thermometer which will give the temperature of the copper interior from moment to moment.

[1] "This is the case at present, but there would not be any great difficulty in modifying it so as to act as required. It is quite a matter worth consideration whether a differential air-thermometer would not be very suitable, one bulb silvered and the other blackened or of green glass, as I suggested to the Meteorological Council some years back. By this means only *one* reading would be necessary, whilst in the plan suggested two would have to be recorded, and the measurements would be more difficult." (*Note by Capt. Abney.*)

(2) In the middle of the inclosure is to be placed the thermometer, upon which the heat of the sun is made to fall by means of a hole in the inclosure, either with or without a lens. This thermometer should be so constructed as to be readily susceptible to solar influences. It is proposed to make it of green glass (a good absorber and radiator), and to give it a flattened surface in the direction perpendicular to the light from the hole. Such an instrument should be so adjusted as to receive the sun's light continuously through the hole, and the objects of record would be the simultaneous heights of the two thermometers, the one giving the temperature of the inclosure, and the other of the central thermometer. There are two conceivable methods by which the necessary adjustment with regard to the sun's light might be secured, namely, (α) the inclosure might be subject to an equatorial motion so as to follow the sun, or (β) the inclosure might be kept at rest and the solar rays kept upon the hole by a heliostat. Capt. Abney is of opinion that the latter arrangement is, mechanically, much preferable to the former. As the direction of the earth's axis may be chosen as that into which the sun's light is to be reflected, a heliostat of a very simple construction will suffice; and as the angle of incidence on the mirror of such a heliostat changes only very slowly with the season, there is no difficulty in applying the small correction required for the change in the intensity of the reflected heat consequent on the change in the angle of incidence. It is assumed that the mirror of the heliostat is a speculum. It has been remarked by Gen. Strachey that some such instrument as this now suggested, even if not made self-recording, would have the advantage of giving an observation without the objectionable necessity of putting the light on for a given time, and then shutting it off, operations only suitable for trained observers. We think that it would be desirable to construct an inclosure with its two thermometers such as herein recorded. In all probability the loan of a heliostat and of an actinometer might be obtained. By aid of the heliostat the sun's light might be kept continuously upon the hole of the inclosure. The two thermometers would be read, and the results compared with the simultaneous reading of an ordinary actinometer. By such means it is believed that the best method of constructing such an instrument and observing with it might be found. We would therefore ask for a continuance of our Committee, with the sum of 30*l.* to be placed at our disposal for the purpose herein specified.

Report of the Committee, consisting of Mr. Sclater, Mr. Howard Saunders, and Mr. Thiselton Dyer (Secretary), appointed for the Purpose of Investigating the Natural History of Timor Laut.—Since our last report was presented to the Association, Mr. Forbes's botanical collection—which, from the result of an unfortunate fire in the drying-house in which the Herbarium had to be prepared, was very small, as he deplores—has been handed over to the Royal Herbarium at Kew. Of this collection Sir Joseph Hooker, at a meeting of the Royal Geographical Society on January 28, 1884, made the following remarks:—"From that time [of the appearance of Prof. Decaisne's 'Flora Timoriensis'] to this, the limits of the Australian flora, so long supposed to have been circumscribed with exactitude, have never been laid down, though it has been enormously enlarged to the north by the inclusion of the great island of Papua, which is to a great extent Australian in its biology, and by that of sundry other islets to the north-east and north-west. It is under this point of view that Mr. Forbes's collections are so important. It is true that for the most part they consist of what are generally known as *coral-island* plants. . . . But besides this there are some peculiar forms, and there are two plants of extraordinary interest which I would simply instance as being typical—one of the new Hebridean and one of the Australian flora. It so happened that these two plants belonged to unispecific genera. . . . The existence of these plants pointed to some old communication between these particular islands." No detailed account of the ethnographical collection has yet been published; but as the collection has been deposited in the British Museum, a description of the Timor Laut objects will doubtless appear in the Catalogue of the Ethnological Department, while the more interesting will be figured in Mr. Forbes's forthcoming volume. At the last meeting of the Association at Southport, Dr. J. G. Garson ("Report," p. 566) read a short account of the crania (now in the British Museum) brought from Larat by Mr. Forbes, which has been published *in extenso* in the *Journal* of the Anthropological Institute, vol. xiii., and which concludes with the following remarks on the relation of the inhabitants of

Timor Laut to those of adjacent countries:—"That the skulls just described are not those of a pure race is very evident. Two very distinct types can be made out, namely, the brachycephalic and the dolichocephalic, the former greatly predominating in number. Both from the information Mr. Forbes has given us as to their appearance, and from the skulls themselves, there is no difficulty in recognising a strong Malay element in the population. The male skull No. 4, and the female No. 6, are typically Malayan in their characters, especially in possessing large, open, rounded orbits, and smooth forehead, the superciliary ridges and glabella being almost entirely absent. The other brachycephalic skulls, though not presenting such a striking affinity, agree more or less with this type, but give evidence of mixed characters. The dolichocephalic skull is, on the other hand, markedly of the Papuan type, and corresponds so closely as to be undistinguishable from two crania obtained twenty miles inland from Port Moresby, New Guinea, in the College of Surgeons' Museum, also from another from the Solomon Islands. Along with this form of skull, Mr. Forbes informs me, is associated frizzly hair and dark skin. The examination of the cranial characters of the inhabitants of Timor Laut, as illustrated by the skulls before us, shows that the peopling of this island is no exception to what is usually found in the various groups of islands in the Polynesian Archipelago. From its close proximity to New Guinea, perhaps more of the Papuan element might have been expected." In addition, the *Coleoptera* sent home have been examined and described in a recent paper by Mr. C. O. Waterhouse, published in the Zoological Society's *Proceedings*. The number of species collected was twenty-nine; of these the following deserve special notice on account of their geographical distribution:—*Diaphœtes rugosus*, a new genus and species of *Staphylinidæ* known from Java; *Cyphogastra angulicollis*, only previously known from Banda; *C. splendens*, a new species allied to the preceding; *Archetypus rugosus*, belonging to a genus of Longicorns, of which there was only one species previously known, which species occurs in Waigiou, Dorey, and Aru; *Nemophas forbesii*, a new Longicorn nearly allied to *N. grayi* from Amboina. Further, a new species of ground thrush (*Geocichla machiki*) has been described by Mr. Forbes from additional specimens brought home by himself on his return. So that our knowledge of the avifauna of this region has been increased by the addition of twenty-four new species, entirely collected on the few square acres to which the inter-tribal wars of the natives restricted Mr. Forbes's operations. At the presentation of our last report, Mr. Forbes, who had just returned to England, gave a short description of the region visited by him; but at the meeting of the Royal Geographical Society, to which we have referred above, he gave a more detailed account, which has been published, illustrated by a map, in their *Proceedings* for March, embodying the geographical observations made by him. The collections of Fishes, Crustacea, and Hydrozoa, though containing much that was of interest, added few species that were new to science. A statement in our last report, on p. 227, that "the total expense of Mr. Forbes's expedition has amounted to 300*l*." ought perhaps to be corrected, as we understand from Mr. Forbes that the total cost was more than double this sum.

Report of the Committee, consisting of Mr. John Cordeaux (Secretary), Prof. Newton, Mr. J. A. Harvie-Brown, Mr. William Eagle Clark, Mr. R. M. Barrington, and Mr. A. G. More, reappointed at Southport for the Purpose of Obtaining (with the Consent of the Master and Brethren of the Trinity House and the Commissioners of Northern and Irish Lights) Observations on the Migrations of Birds at Lighthouses and Light-vessels, and of reporting on the same.—The General Report[1] of the Committee, of which this is an abstract, comprises observations taken at lighthouses and light-vessels, as well as at several land stations, on the east coast of England, the east and west coasts of Scotland, the coasts of Ireland, also the Channel Islands, Orkney and Shetland Isles, the Hebrides, Faroes, Iceland and Heligoland, and one Baltic station on the coast of Zealand, for which the Committee is again indebted to Prof. Lütken of Copenhagen. Altogether 158 stations have been supplied with schedules and letters of instruction for registering observations, and returns have been received from 102. The best thanks of the Committee are due to their numerous observers for the generally careful and painstaking manner in which they have filled up the schedules, and the very intelligent interest taken by them in the inquiry. Special thanks must be accorded to Messrs. H. Gätke, Heligoland; H. C. Müller, Faroe; and M. Thorlacius, Skykkesholm, Iceland, for the notes sent in from their respective stations; also to Mr. J. H. Gurney, for having commenced on the south-east coast of England a similar system of inquiry, which, for a first trial, has worked well. In all doubtful cases of identity, where birds are killed against the lantern, a wing is cut off, and a label, with the date, attached. These have been forwarded in batches to Mr. Gurney for identification, and with most satisfactory results. The Committee regret that for the second year in succession they have received no report from the west coast of England. A late member of the Committee, Mr. Philip M. C. Kermode, having failed to make any returns, or to send the collected schedules, although repeatedly requested, to Mr. W. E. Clarke, who had undertaken the work of tabulating and reporting on the same, provision has been made by the Committee for supplying the deficiency in any subsequent years. The observations taken on the east coast of Great Britain in 1883 have been such as generally to confirm the conclusions arrived at in former reports, having reference to direction of flight and lines of migration. The winter of 1883-4 has been exceptionally mild, and there has been an almost entire absence of severe frosts and lasting snow-storms; the prevailing winds in the autumn, west and south-west, such as observation shows are most favourable for migrants crossing the North Sea and continuing their journey inland. Winds from opposite quarters to these tire out the birds and cause them to drop directly they reach land. Our land stations report a great scarcity both of land and sea birds; this has not, however, been the case at sea stations—that is, light-vessels moored off the coast at distances varying from five to fifty miles. Here the stream of migration, so far from showing any abatement, has flown steadily on in a full tide; and, if we judge from the well-filled schedules which have been returned, there has been a considerable increase in the visible migration, due perhaps in some measure to increased interest and improved observation. Mr. William Stock, of the Outer Dowsing light-vessel, remarks that he had never before seen so many birds pass that station; the rush, also, across and past Heligoland in the autumn was enormous. Migration is more marked, as well as concentrated, there, than at any station on the English coast. There was a great movement of various species passing forward on August 6 and 7, and again on the 14th, and more pronounced still on the 21st and 22nd, and on August 20 a similar movement was noticed at the Isle of May, at the mouth of the Firth of Forth. It was not, however, until September 21 and the two following days that the first great rush occurred on the English east coast, and a similar great movement or rush is indicated, at the same date, in Mr. Gätke's notes, as well as from the most distant of the lightships. The prevailing winds over the North Sea on September 21 were moderate north-easterly and easterly off the coasts of Denmark and Holland, blowing strong easterly on the coast north of the Humber, with southerly and south-westerly off the south-east coast, producing cross-currents over the North Sea. Whatever was the impulse, atmospheric or otherwise, which induced such a vast rush of various species at this time, it was one which acted alike, and with precisely the same impulse, on the sea-eagle and the tiny goldcrest. The second great rush was on October 12 and 13, a similar movement being recorded at Heligoland. Then, again, from the 27th to the 31st, and somewhat less through the first week in November, the passage across Heligoland, as well as the rush on our east coast, was enormous. Speaking of the nights from the 27th to the 31st inclusive, Mr. Gätke says: "This was the first move by the million; for four nights there has been a gigantic feathery tide running." During this time there were variable winds over the North Sea, but generally easterly and south-easterly on the Continent, strong west winds and squalls prevailing generally on November 5 and 6. Again, with the outburst of some severe weather in the first week in December, a considerable local movement is indicated along the coast from north to south, culminating in the enormous rush of snow-buntings into Lincolnshire about the end of the first week in that month. A careful perusal of the report will show how generally the rushes across Heligoland correlate with those on the east coast of England, although not always confined to identical species. A somewhat remarkable and very anomalous movement of migrants is recorded from light-vessels of the Lincolnshire and Norfolk coasts in the spring of 1883. In February, March, April, and May, birds passing the Leman and Ower, Llyn Wells, Outer Dowsing, Newarp and the Cockle light-

[1] "Report on the Migration of Birds in the Spring and Autumn of 1883." (West, Newman, and Co., 54, Hatton Garden, London, E.C.).

vessels, were, as a rule, coming from *easterly* and passing in *westerly* directions. The entries show a great immigration of our ordinary autumn migrants from the east in the spring months, and on exactly the same lines and directions as are travelled by the same species in autumn. Had this movement been observed at one station only, we might perhaps have been induced to doubt the accuracy of the return, but the fact of five light-vessels, having no communication with each other, reporting the same circumstances, proves the correctness of the observations. On the east coast of Scotland Mr. J. A. Harvie-Brown says that the autumn migration of 1883 was pronounced, culminating in a grand rush from October 28 to November 3. The heaviest rush of birds, as compared with other years, was observed at the Isle of May on October 13 and 14. This was with a south wind, although as a rule it is a south-east wind at that point which brings the greatest flights. In the autumn of 1882, on the east coast of Scotland, the bulk of immigrants are recorded at the southern stations; in 1883 these conditions were reversed, the bulk being recorded from northern stations. On the east coast of England, in 1883, birds appear to have been very equally distributed over the whole coast-line. It will be gathered from the General Report that the dates of the rushes on the east coast of Scotland were slightly later than those on the east coast of England, and that the migrations past the more northerly stations in Scotland were in proportion later than in the south, and also that the dates of the heaviest rushes on the east coast agree fairly with the dates from the west coast. From the coasts of Ireland Messrs. A. G. More and R. M. Barrington report a decided improvement in filling up the schedules, in some cases three or four being returned from the same station. Forty-two stations were supplied with schedules in the spring of 1883, and thirty-five in the autumn of the same year, returns coming in from thirty-four, one only failing. The number of migrants in the autumn seems to have been more than usual. A great rush of thrushes (including, probably, redwings), blackbirds, and starlings, took place at the south-eastern and southern stations between October 25 and November 2—dates which agree with the great rush on the east coast of England. The migration was particularly marked at the Tuskar Rock, off the Wexford coast, which is proving itself the best Irish station, and no doubt marks the line of the chief passage from the British coast. The bulk of the immigrants appear to arrive on the south-eastern coast of Ireland, excepting such birds as the bernicle-goose and snow-bunting, which are mainly recorded from north-western stations, and rarely entered in schedules from the east or south coast. An interesting feature this year is the occurrence of several examples of the Greenland falcon on the west coast, no less than eight having been shot at various points from Donegal to Cork, and one Iceland falcon at Westport. Independent of the ordinary notes on migration, the general remarks of the light-keepers with reference to the nesting of sea-fowl on the islands or outlying skerries are of great interest, and no matter what results are arrived at from this special inquiry, it is satisfactory to be in correspondence with such a number of observers at isolated spots around the coast, and the information supplied cannot fail to be of much interest to future compilers. An interesting feature of the autumn migration is the occurrence of a flight of the blue-throated warbler (*Cyanecula suecica*). A single adult with bright-blue breast was observed at the Isle of May on the night of September 2–3. On the east coast of England twelve were obtained, all being birds of the year, and of these nine on the coast of Norfolk, besides about twenty others seen by competent observers. Very few goldcrests, compared with the enormous flights of the previous autumn, have appeared, and the same scarcity is observable in the Heligoland returns. Curiously enough, the hedge-sparrow (*Accentor modularis*), which migrated in immense numbers in the same autumn, has been almost entirely absent. About half a dozen are recorded at Heligoland, none on the east coast of England. Of the enormous immigration which crosses our east coast in the autumn, either to winter in these islands or merely on passage across them, a small proportion only appear to return by the same routes. Spring returns from lighthouses and light-vessels show that birds then move on the same lines as in the autumn, but in the reverse direction. These return travellers do not, however, represent anything like a tithe of the visible immigrants which, week after week and month by month, in the autumn, move in one broad stream on to the east coast. What is called the "first flight" of the woodcock arrived on the Yorkshire, Lincolnshire, and Norfolk coasts on the night of October 21. The "great flight," or rush, which covered the whole of the east coast from the Farne Islands to Yarmouth was on the nights of the 28th and 29th. These two periods correlate with the principal flights of woodcock across Heligoland. But few woodcock were recorded from stations on the east coast of Scotland, although at the Bell Rock Lighthouse, on the night from October 31 to November 1, Mr. Jack reports an enormous rush of various species, commencing at 7 p.m. Immense numbers were killed, pitching into the sea. "What we thought were woodcocks struck with great force; birds continued flying within the influence of the rays of light till the first streak of day, continually striking hard all night; we believe a great number of woodcocks struck and fell into the sea." Mr. Harvie-Brown records a very great spring migration of woodcock which appear to have crossed Scotland between the Clyde and the Forth on March 9, 10, 11, and 12, 1884. These were observed to be the small red Scandinavian bird, which are quite unmistakable and distinct from British-bred birds. The occurrence of *Locustella fluviatilis* at the Stevns Lighthouse at the entrance of the Oresund in Zealand is interesting, as it is the first recorded Danish example of this species. Altogether there has been a very marked absence on our British coasts of rare and casual visitants. The roller (*Coracias garrula*) occurred in October in two localities—one in Lincolnshire, the other in Suffolk. Two examples of the sooty shearwater (*Puffinus griseus*) were obtained in Bridlington Bay about the end of September. The island of Heligoland retains its pre-eminence as the casual resting-place of rare wanderers from other lands; and Mr. Gätke's list for 1883 includes *Turdus varius*, *Pratincola rubicola*, var. *indica*, *Phylloscopus superciliosus*, *Hypolais pallida*, *Motacilla citreola*, *Anthus cervinus*, *A. richardi*, *Oriolus galbula*, *Lanius major*, *Muscicapa parva*, *Linota exilipes*, *Emberiza melanocephala*, *E. cirlus*, *E. rustica*, *E. pusilla*, *Pastor roseus*, and *Xema sabinii*. It is well known that large numbers of European birds, presumably driven out of their course, are seen during the autumn migration far out over the Atlantic, alighting on the ocean-going steamers. It is proposed by Mr. Harvie-Brown to supply schedules to the principal lines of ocean steam-vessels for the better recording of these occurrences. It must be borne in mind that the immense and constantly-increasing traffic which in these days bridges the Atlantic and unites the Old and New Worlds, offers unusual chances for birds to break their flight, and ultimately, perhaps, to reach the American coast. In the comparatively narrow seas between the European continent and Great Britain birds are frequently noted as alighting on the rigging of vessels and light-ships, roosting in the rigging during the night, to resume their flight at the first streak of dawn. It is a matter of congratulation that our American and Canadian fellow-workers have instituted a similar system of observation on the migration of birds. At the first Congress of the American Ornithologists' Union, held at New York City, September 26 to 28, 1883, a Committee on the Migration of Birds was appointed. It is intended to investigate this in all its bearings and to the fullest possible extent, not only in the accumulation of records of the times of arrival and departure of the different species, but to embrace the collection of all data that may aid in determining the causes which influence migration from season to season. Your Committee respectfully request their reappointment, and trust that the Association will enable them to continue the collection of facts.

Tenth Report of the Committee, consisting of Prof. E. Hull, the Rev. H. W. Crosskey, and Messrs. James Glaisher, H. Marten, E. B. Marten, G. H. Morton, W. Pengelly, James Plant, I. Roberts, Thos. S. Stooke, G. J. Symons, W. Topley, E. Wethered, W. Whitaker, and C. E. De Rance (Secretary and Reporter), appointed for the Purpose of Investigating the Circulation of Underground Waters in the Permeable Formations of England and Wales, and the Quantity and Character of the Water Supplied to Various Towns and Districts from those Formations. Drawn up by C. E. De Rance.—The Chairman and Secretary of your Committee are both unavoidably obliged to be absent from the Montreal meeting, which is a source of regret to themselves; the more so that, this being the case, it has been thought advisable to delay presenting their final Report on the Circulation of Underground Waters in South Britain until next year, when the Committee will have been twelve years in existence. During these years particulars have been collected

of the sections passed through by a very large number of wells and borings; a daily record has been obtained of the height at which water stands in many of these wells; investigations have been carried out as to the quantity of water held by a cubic foot of various rocks, by Mr. Wethered; and as to the filtering power of sandstones, and the influence of barometric pressure and lunar changes on the height of underground waters, by Mr. I. Roberts. During the present year the attention of the Committee has been directed to the remarkable influence of the earthquake which visited the East and East-Central Counties of England in March last, in raising the levels of the water in the wells of Colchester and elsewhere. More detailed information is still required as to the proportion of actual rainfall absorbed by various soils, over extended periods representing typical dry and wet years. Information on these heads and on other points of general interest bearing on the percolation of underground waters, referring to observations made in Canada or the United States, would be gladly welcomed by the Committee, and would be incorporated in their eleventh and final Report to be presented next year. Your Committee seek reappointment, but do not require a grant, as they have forms of inquiry on hand, and did not require to expend the whole of the grant of last year, a portion of which only has been drawn.

Appendix—Copy of Questions.—1. *Position* of well or shafts with which you are acquainted. 1*a*. State *date* at which the well or shaft was originally sunk. Has it been deepened since by sinking or boring? and when? 2. Approximate *height* of the surface of the ground above Ordnance Datum (mean sea-level). 3. *Depth* from the surface to bottom of shaft or well, with diameter. *Depth* from surface to bottom of bore-hole, with diameter. 3*a*. *Depth* from the surface to the horizontal drift-ways, if any. What is their length and number? 4. *Height* below the surface at which water stands *before* and *after* pumping. Number of hours elapsing before ordinary level is restored after pumping. 4*a*. *Height* below the surface at which the water stood when the well was first sunk, and height at which it stands now when not pumped. 5. *Quantity* capable of being pumped in gallons per day of twenty-four hours. Average quantity daily pumped. 6. Does the *water-level* vary at different seasons of the year, and to what extent? Has it diminished during the last ten years? 7. Is the ordinary *water-level* ever affected by local rains, and, if so, in how short a time? And how does it stand in regard to the level of the water in the neighbouring streams, or sea? 8. *Analysis* of the water, if any. Does the water possess any marked *peculiarity?* 9. *Section*, with nature of the rock passed through, including cover of Drift, if any, with *thickness*. 9*a*. In which of the above rocks were springs of water intercepted? 10. Does the cover of Drift over the rock contain *surface springs?* 11. If so, are these *land springs* kept entirely *out* of the well? 12. Are any large *faults* known to exist close to the well? 13. Were any *brine springs* passed through in making the well? 14. Are there any *salt springs* in the neighbourhood? 15. Have any wells or borings been discontinued in your neighbourhood in consequence of the water being more or less *brackish?* If so, please give section in reply to query No. 9. 16. Kindly give any further information you can.

PENDING PROBLEMS OF ASTRONOMY[1]

THIRTY-SIX years ago this very month, in this city, and near the place where we are now assembled, the American Association for the Advancement of Science was organised, and held its first meeting. Now, for the first time, it revisits its honoured birthplace.

Few of those present this evening were, I suppose, in attendance upon that first meeting. Here and there, among the members of the Association, I see, indeed, the venerable faces of one and another, who, at that time in the flush and vigour of early manhood, participated in its proceedings and discussions; and there are others, who, as boys or youths, looked on in silence, and listening to the words of Agassiz and Peirce, of Bache and Henry, and the Rogers brothers and their associates, drank in that inspiring love of truth and science which ever since has guided and impelled their lives. Probably enough, too, there may be among our hosts in the audience a few who remember that occasion, and were present as spectators.

[1] Address to the American Association for the Advancement of Science at Philadelphia, September 5, by Prof. C. A. Young, Professor of Astronomy at Princeton, retiring President of the Association. We are indebted to the courtesy of the editor of *Science* for an early copy of Prof. Young's address.

But, substantially, we who meet here to-day are a new generation, more numerous certainly, and in some respects unquestionably better equipped for our work, than our predecessors were, though we might not care to challenge comparisons as regards native ability, or clearness of insight, or lofty purpose.

And the face of science has greatly changed in the meantime; as much, perhaps, as this great city and the nation. One might almost say, that, since 1848, "all things have become new" in the scientific world. There is a new mathematics and a new astronomy, a new chemistry and a new electricity, a new geology and a new biology. Great voices have spoken, and have transformed the world of thought and research as much as the material products of science have altered the aspects of external life. The telegraph and dynamo-machine have not more changed the conditions of business and industry than the speculations of Darwin and Helmholtz and their compeers have affected those of philosophy and science.

But, although this return to our birthplace suggests retrospections and comparisons which might profitably occupy our attention for even a much longer time than this evening's session, I prefer, on the whole, to take a different course; looking forwards rather than backwards, and confining myself mainly to topics which lie along the pathway of my own line of work.

The voyager upon the Inland Sea of Japan sees continually rising before him new islands and mountains of that fairy-land. Some come out suddenly from behind nearer rocks or islets, which long concealed the greater things beyond; and some are veiled in clouds which give no hint of what they hide, until a breeze rolls back the curtain; some, and the greatest of them all, are first seen as the minutest specks upon the horizon, and grow slowly to their final grandeur. Even before they reach the horizon line, while yet invisible, they sometimes intimate their presence by signs in sky and air; so slight, indeed, that only the practised eye of the skilful sailor can detect them, though quite obvious to him.

Somewhat so, as we look forward into the future of a science, we see new problems and great subjects presenting themselves. Some are imminent and in the way,—they must be dealt with at once, before further progress can be made; others are more remotely interesting in various degrees; and some, as yet, are mere suggestions, almost too misty and indefinite for steady contemplation.

With your permission, I propose this evening to consider some of the pending problems of astronomy,—those which seem to be most pressing, and most urgently require solution as a condition of advance; and those which appear in themselves most interesting, or likely to be fruitful, from a philosophic point of view.

Taking first those that lie nearest, we have the questions which relate to the dimensions and figure of the earth, the uniformity of its diurnal rotation, and the constancy of its poles and axis.

I think the impression prevails that we already know the earth's dimensions with an accuracy even greater than that required by any *astronomical* demands. I certainly had that impression myself not long ago, and was a little startled on being told by the superintendent of our "Nautical Almanac" that the remaining uncertainty was still sufficient to produce serious embarrassment in the reduction and comparison of certain lunar observations. The length of the line joining, say, the Naval Observatory at Washington with the Royal Observatory at the Cape of Good Hope is doubtful—not to the extent of only a few hundred feet, as commonly supposed, but the uncertainty amounts to some thousands of feet, and may possibly be a mile or more, probably not less than a ten-thousandth of the whole distance; and the *direction* of the line is uncertain in about the same degree. Of course, on those portions of either continent which have been directly connected with each other by geodetic triangulations, no corresponding uncertainty obtains; and as time goes on, and these surveys are extended, the form and dimensions of each continuous land-surface will become more and more perfectly determined. But at present we have no satisfactory means of obtaining the desired accuracy in the relative position of places separated by oceans, so that they cannot be connected by chains of triangulation. Astronomical determinations of latitude and longitude do not meet the case; since, in the last analysis, they only give at any selected station the *direction of gravity* relative to the axis of the earth, and some fixed meridian plane, and do not furnish any *linear* measurement or dimension.

Of course, if the surface of the earth were an exact spheroid, and if there were no irregular attractions due to mountains and valleys and the varying density of strata, the difficulty could be