but before he came, "the bow," to quote Mr. Tennyson's words, "had assumed its usual colours, which were, however, very faint." Mrs. Tennyson says the pink colour "was visible for a very little time just at sunset, and then I saw a dull olive green at the lower edge." After that, as Mr. Tennyson says, we all saw the vanishing ghost, as it were, of an ordinary rainbow. The actual uniform redness came just at sunset, as marked in the almanac we consulted—ten minutes past seven. A. M.

August 26

The Glacial Period

PLEASE correct an error in the notice of my paper on the Glacial Period (NATURE, vol. xxiv. p. 364). It is on the western slope of New Zealand that the glaciers reach to the highest mean annual temperature (10° C., or 50° F.) as well as to the lowest level. *Apropos* of my studies on this subject, I should be very glad to meet some of the British glacialists at Venice, at the third International Geographical Congress, and discuss some points of interest with them. As there is, a few days later, an International Geological Congress at Bologna, it will be the easier for geologists to make a short stay at Venice before. The Geographical Congress begins on September 15.

St. Petersburg, August 13–25 A. WOEIKOF

THE BRITISH ASSOCIATION

THE Jubilee Meeting of the British Association has come to a close, and whether we take the test of work done, or of the numbers present as members or associates, it must be admitted that it has been a great success. While in 1879, in the densely populated town of Sheffield, the total was 1404, and at Swansea last year 915, the number has risen this year to 2533, which includes 22 foreign members, 510 ladies, and 1173 associates. Of course York does not supply the whole of the latter: many come from Leeds, Sheffield, and Scarborough, and the surrounding towns. Seven times previously has the number been greater; the maximum (3335) having been attained at Newcastle-on-Tyne in 1863. As regards work done, it may be mentioned that on Friday nearly a hundred papers were announced for reading in the various sections. One of the laws of the Jewish jubilee festival was that the land should remain untilled for a year; but we have reversed this, and only cultivated our scientific soil the more. Sir David Brewster, in the original letter which laid the foundations of the society, suggested York as the most central city of the three kingdoms, but he first inquired "if York will furnish the accommodation necessary for so large a meeting, which might perhaps consist of 100 individuals." Apparently therefore he did not contemplate the admission of associates, or the use of the Association as a means of scattering broadcast the results of the scientific year, but rather regarded it as a means whereby the cultivators of science might become better acquainted with each other at a time when communication with London was far more difficult, and intercourse through scientific publications far more restricted than now. But the first meeting numbered 350 members, and included some of the most representative men of science of the day. On this occasion the presidential address lasted five minutes.

The proceedings commenced on Wednesday, August 31, by the reading of the Report of the Council, in which it was announced that Mr. P. L. Sclater had resigned the office of general secretary, and that he would be succeeded by Mr. F. M. Balfour of Cambridge. Mr. G. E. Gordon has also retired from the assistant secretaryship, and is to be succeeded by Prof. Bonney, with the title of secretary and a salary of 300*l.* per annum, with 25*l.* for travelling expenses. Mr. Spottiswoode succeeds Sir Philip de Malpas Grey Egerton as trustee.

The new members of council are Messrs. Warren De La Rue, A. Vernon Harcourt, G. W. Hastings, J. C. Hawkshaw, and G. Prestwich.

Sir John Lubbock's address was listened to by a very crowded audience. The Exhibition Hall is a fine building, and was prettily decorated, but its acoustic properties are somewhat deficient, and the unsteady electric light was painful to the eyes. The address occupies fifty octavo pages, of which nearly twenty were omitted during delivery. On the subject of education the President expressed himself strongly; he asked that more time should be given to French, German, science, and mathematics. "What we ask is that, say, six hours a week each should be devoted to mathematics, modern languages, and science, an arrangement which would still leave twenty hours for Latin and Greek"; and he added, "we cannot but consider that our present system of education is, in the words of the Duke of Devonshire's Commission, little less than a national misfortune."

Sir John Lubbock adopted a judicious mean between the address devoted entirely to one subject on the one hand, and giving a general *résumé* of the progress of all the sciences on the other; for while he spoke in detail and authoritatively concerning the biological sciences, he also furnished accounts of the progress of the physical sciences, prepared by men well competent to discuss them.

The Section work began in earnest on Thursday morning. Some idea of the number of representative men who were present at the meeting may be gathered from the fact that in Section A there are ten vice-presidents and fifty-seven members of committee, and these numbers are exceeded in some of the sections; so that there are more than fifty vice-presidents of sections, and more than three hundred members of sectional committees. The sections were housed in capacious and very suitable rooms, and the attendance was very good.

The loan collection of scientific apparatus, although it contained some very interesting examples, was by no means a collection which represents the experimental progress of the last fifty years, and the appeal for historical apparatus has scarcely been responded to. The exhibition was shown at the Thursday *soirée*, and remained open till the end of the week of meeting. A good catalogue of thirty-two pages was prepared. We may particularly notice some beautifully-finished telescopes and transit instruments, and an electric chronograph exhibited by Messrs. T. Cooke and Sons; a model of the Vienna 27-inch refractor and its dome by Mr. Howard Grubb; and a very old telescope constructed by Abraham Sharp. The Manchester Literary and Philosophical Society exhibited some of the apparatus used by John Dalton in his researches; and the Science and Art Department sent astrolabes and sun-dials of the sixteenth, seventeenth, and eighteenth centuries. A few instruments were sent by foreign makers. Dr. Stone exhibited a large syren fitted with a key-board and worked at an uniform rate by clockwork. A quantity of physiological apparatus was exhibited by Dr. Burdon-Sanderson and Mr. G. B. Thistleton. Mr. Francis Galton exhibited and explained his composite photographic process, "a method of superposing the images of separate portraits and thence creating a face, the sum of all the components employed; it has a curious air of individuality about it, but is a perfectly ideal face, like all, but exactly resembling none." Dr. Tempest Anderson, one of the local secretaries, exhibited some ophthalmic appliances. The North-Eastern Railway Company exhibited an interesting meteorite which fell on March 14 last between the Middlesbrough and Ormesby stations of the Guisborough line. It is of the stony tufaceous type, and weighs three and a half pounds.

On Friday afternoon several manufactories were visited, also the gas-works and water-works. Messrs. Cooke's works were of especial interest, particularly the processes connected with the grinding of lenses and the graduation of circles by means of a large dividing-engine, the great circle of which is marked with divisions, each of which is

© 1881 Nature Publishing Group

equal to five minutes of arc. Saturday afternoon was as usual devoted to excursions, but the steady downpour of rain did much to mar the enjoyment. Several people in the vicinity of York have entertained the members very hospitably, and have thrown open their houses. On Monday the usual meteorological breakfast took place; forty persons were present, and meteorology was the chief order of the day in Section A. In the evening Mr. Spottiswoode gave a discourse on "The Electric Discharge." The Red Lion Club met on Tuesday before the *soirée*.

Southampton has been chosen as the place of meeting in 1882, and Dr. C. W. Siemens has been elected president. A vigorous contest for the honour of receiving the Association took place yesterday between six towns:—Leicester, Nottingham, Southport, Oxford, Birmingham, and Aberdeen. The claims of each town were stated by delegates, and afterwards votes were taken by a show of hands. Birmingham withdrew. The President of the Royal Society, Sir Joseph Hooker, and Professors Acland, H. J. S. Smith, and Prestwich, strongly advocated the claims of Oxford, and the show of hands was declared to be in its favour. Southport was second on the list. Worcester has lodged a claim for 1884.

Altogether more than three hundred papers or reports have been read.

Eighteen papers were put on the list of Section A for Tuesday; twenty-eight in the Geological Section, thirteen in that of Anthropology, and fifteen in Mechanical Science. Thus the work has never flagged at all.

At the Committee Meeting on Wednesday Capt. Bedford Pim gave notice of motion that the meeting be held in Canada in 1885.

The following grants have been made:—

	£
The Council—Exploration of Mountain District of Eastern Equatorial Africa	100
A—Mathematics and Physics	
Mr. G. H. Darwin—Lunar Disturbance of Gravity	15
Dr. A. Schuster—Meteoric Dust	20
Prof. Sylvester—Fundamental Invariants (partly renewed)	80
Mr. R. H. Scott—Synoptic Charts of the Indian Ocean	50
Prof. G. C. Foster—Standards for Use in Electrical Measurements (partly renewed)	100
B—Chemistry	
Prof. Dewar—Present State of Knowledge of Spectrum Analysis	5
Prof. Balfour Stewart—Calibration of Mercurial Thermometers	20
Prof. Roscoe—Wave-lengths Tables of Spectra of Elements	50
Dr. Hugo Müller—Chemical Nomenclature	10
Prof. Odling—Photographing the Ultra-Violet Spark Spectra	25
C—Geology	
Dr. J. Evans—Record of the Progress of Geology	100
Prof. Ramsay—Earthquake Phenomena of Japan	25
Dr. H. C. Sorby—Conditions of Conversion of Sedimentary Materials into Metamorphic Rocks	10
Prof. W. C. Williamson—Fossil Plants of Halifax	15
Dr. Sorby—Conversion of Sediments into Metamorphic Rocks	10
Prof. A. C. Ramsay—Geological Map of Europe	25
Prof. E. Hull—Circulation of Underground Waters	15
Prof. W. C. Williamson—Tertiary Flora associated with the Basalts of the North of Ireland	20
Dr. Sorby—British Fossil Polyzoa	10
Prof. Leith-Adams—Carboniferous Limestone Caves in South Ireland	10
Prof. Green—Exploration of Raygill Fissure	20
D—Biology	
Mr. F. M. Balfour—Table at the Zoological Stations at Naples	80
Dr. Burdon-Sanderson—Albuminoid Substances of Serum	10
Dr. Pye Smith—Influence of Bodily Exercise on the Elimination of Nitrogen	50
Dr. M. Foster—Zoological Station in Scotland	£40
Mr. J. Cordeaux—Migration of Birds	15
Lieut.-Col. Godwin-Austen—Natural History of Socotra	100
Mr. Staniton—Record of Zoological Literature	100
Mr. Sclater—Natural History of Timorlaut	100
Prof. Flower—Photographs of Typical Races	10
Statistics	
Mr. F. Galton—Anthropometrics	50

SECTION A

MATHEMATICAL AND PHYSICAL

OPENING ADDRESS BY SIR WILLIAM THOMSON, F.R.S., PROFESSOR OF NATURAL PHILOSOPHY IN THE UNIVERSITY OF GLASGOW, PRESIDENT OF THE SECTION

On the Sources of Energy in Nature Available to Man for the Production of Mechanical Effect

DURING the fifty years' life of the British Association, the Advancement of Science for which it has lived and worked so well has not been more marked in any department than in one which belongs very decidedly to the Mathematical and Physical Section—the science of Energy. The very name energy, though first used in its present sense by Dr. Thomas Young about the beginning of this century, has only come into use practically after the doctrine which defines it had, during the first half of the British Association's life, been raised from a mere formula of mathematical dynamics to the position it now holds of a principle pervading all nature and guiding the investigator in every field of science.

A little article communicated to the Royal Society of Edinburgh a short time before the commencement of the epoch of energy under the title "On the Sources Available to Man for the Production of Mechanical Effect"[1] contained the following:—

"Men can obtain mechanical effect for their own purposes by working mechanically themselves, and directing other animals to work for them, or by using natural heat, the gravitation of descending solid masses, the natural motions of water and air, and the heat, or galvanic currents, or other mechanical effects produced by chemical combination, but in no other way at present known. Hence the stores from which mechanical effect may be drawn by man belong to one or other of the following classes:—

"I. The food of animals.

"II. Natural heat.

"III. Solid matter found in elevated positions.

"IV. The natural motions of water and air.

"V. Natural combustibles (as wood, coal, coal-gas, oils, marsh-gas, diamond, native sulphur, native metals, meteoric iron).

"VI. Artificial combustibles (as smelted or electrically-deposited metals, hydrogen, phosphorus).

"In the present communication, known facts in natural history and physical science, with reference to the sources from which these stores have derived their mechanical energies, are adduced to establish the following general conclusions:—

"1. *Heat radiated from the sun* (sunlight being included in this term) *is the principal source of mechanical effect available to man.*[2] From it is derived the whole mechanical effect obtained by means of animals working, water-wheels worked by rivers, steam-engines, galvanic engines, windmills, and the sails of ships.

"2. The motions of the earth, moon, and sun, and their mutual attractions, constitute an important source of available mechanical effect. From them all, but chiefly no doubt from the earth's motion of rotation, is derived the mechanical effect of water-wheels driven by the tides.

"3. The other known sources of mechanical effect available to man are either terrestrial—that is, belonging to the earth, and available without the influence of any external body—or meteoric—that is, belonging to bodies deposited on the earth from external space. Terrestrial sources, including mountain quarries and mines, the heat of hot springs, and the combustion of native sulphur, perhaps also the combustion of inorganic native combustibles, are actually used, but the mechanical effect

[1] Read at the Royal Society of Edinburgh on February 2, 1852 (*Proceedings* of that date).

[2] A general conclusion equivalent to this was published by Sir John Herschel in 1833. See his "Astronomy," edit. 1849, § (399).

© 1881 Nature Publishing Group