THE MUSEUMS ASSOCIATION.

SOME evidence of the desirability of our educational institutions "carrying on" in war-time is afforded by the excellent results achieved at the annual conference of the Museums Association, held at the Town Hall, Manchester, on July 9–11. In view of the difficulty of entertainment, etc., the conference was curtailed to three days, but as a result of the lengthy sessions each morning and afternoon, and on one evening, probably more actual work was crowded in the three days than during any previous conference. It was remarkably well attended, there being about eighty delegates from England, Scotland, Wales, and Ireland. To the great regret of the members, the president, Mr. E. Rimbault Dibdin, was prevented through illness from attending and giving his address. This was particularly unfortunate in view of the recent efforts of the association to give more prominence to matters connected with the art side of museum work, an aspect which was possibly partly neglected by the association in years gone by. However, by the efforts of the local secretary, Mr. Haward, and the general secretary, Mr. J. Grant Murray, this aspect of the association's work was well to the fore.

The members had the usual experience of hearing a few papers on elementary museum matters, mostly by local authors, but one result of the association's propaganda during the last quarter of a century was amusing. For years the association has endeavoured to make the education committees interested in the museums, and has advocated the appointment of special teachers to devote their time entirely to giving lectures to pupils in museums and art galleries. This has at last been accomplished at Manchester, and, possibly through being unaware of the association's efforts, the various teachers concerned gave details of the nature of their work. The value of museums in war-time was brought prominently forward, and no doubt impressed the various chairmen and members of committees who were present. Bearing more particularly upon the war were:—"The Aims and Objects of the Imperial War Museum," by Lieut. Charles ffoulkes, and "Local War Museums," by Mr. Charles Madeley. Dealing with educational aspects of museums were:—"The Art Museum and the School," by Mr. J. Ernest Phythian; "The Museum in Relation to the School," by (*a*) Mr. R. Saunsbury, (*b*) Mrs. B. Bell, and (*c*) Miss B. Hindshaw; the art side of museum work being represented by "The Preservation, Cataloguing, and Educational Value of Print Collections," by Mr. Isaac J. Williams; "The Museum in Relation to Art and Industry," by (*a*) Mr. Henry Cadness, (*b*) Mr. H. Barrett Carpenter; "The Application of Art to Industry and its Relation to Museum Work," by Mr. S. E. Harrison; "Art Museums," by Mr. Fitzgerald Falkner; and "Material and Design in Relation to Craftsmanship," by Mr. Joseph Burton.

The more general subjects dealt with were:—"The Museum and Trade," by Mr. Thos. Midgley; "A Plea for the District Federation of Museums and Art Galleries," by Mr. Robert Bateman; "Arrangement of an Ethnographical Collection," by Mr. Ben H. Mullen; "Local Museums and their *Rôle* in National Life," by Mr. Louis P. W. Renouf; and "Museum and Art Gallery Finances," by Mr. E. E. Lowe; a little relief being given to the somewhat serious proceedings by a humorous paper on "Packing and Removing a Museum of Geology and Antiquities in War-time," by Mr. Thos. Sheppard.

Before and after the meetings many members visited the museums and art galleries for which the Manchester district is so famous. There was an informal dinner at the conference headquarters, the Grand Hotel, on July 10, under the chairmanship of Dr. W. E. Hoyle, and the Lord Mayor of Manchester provided tea for the members at the Town Hall each day. The president for next year is Sir Henry H. Howarth, and the hon. secretary Mr. W. Grant Murray, of Swansea. At the council meeting, held at the close of the conference, it was agreed that the association should meet again next year.

ECONOMIC RESOURCES OF NEW SOUTH WALES.

THE report of the curator, Mr. R. T. Baker, of the New South Wales Technological Museums for the year 1916 shows that these museums are accomplishing much useful work in adding to our knowledge of the economic resources of New South Wales and in securing the better utilisation of these resources. Increased attention is being given to the native timbers of the Colony, especially for the manufacture of furniture, and the museums staff has been able to assist in this direction by supplying technical information regarding the timbers and by adding to the exhibits numerous examples of Australian workmanship in home-grown timber. An elaborate illustrated monograph on the fishes of Australia and their technology was published during the year by Mr. T. C. Roughley. This is designed to meet the large demand that has arisen with the development of Australian fisheries for accurate information regarding the edible fishes of the country. The book also describes the methods in use in the New South Wales fishing industry. A good deal of research work has been accomplished in spite of the difficulties caused by the war, and the staff has taken part, either in an advisory or executive capacity, in several investigations arranged by the various committees that have been formed in Australia for the promotion of munition manufacture or the development of industrial and scientific research. These include an investigation of the use of grass-tree resins as a source of picric acid (New South Wales Munitions Committee) and an inquiry into the economic possibilities of posidonia fibre (Executive Committee of Science and Industry), two subjects which have long attracted attention both in this country and Australia. Perhaps the best known work of the museums is that on the eucalypts, and it is interesting to note that among the papers published during the year two more on this subject were included, the first on the eucalypts of South Australia and their essential oils, and the other on the essential oil of *E. Macarthuri*.

THE TORNADOES OF THE UNITED STATES.[1]

NATURE of a Tornado.—The relation of a tornado to human life and property depends upon its nature. What it *does* is determined by what it *is*. Briefly stated, a tornado is a very intense, progressive whirl, of small diameter, with inflowing winds which increase tremendously in velocity as they near the centre, developing there a counter-clockwise, vorticular, ascensional movement the violence of which exceeds that of any other known storm. From the violently agitated main-cloud mass above there usually hangs a writhing, funnel-shaped cloud, swinging to and fro, rising and descending. With a frightful roar comes the whirl, advancing almost always towards the north-

[1] By Prof. Robert DeC. Ward, Harvard University, Cambridge, Mass., U.S.A. Abridged by the author from the Quarterly Journal of the Royal Meteorological Society, vol. xliii., No. 183, July, 1917.

east with the speed of a fast train (twenty to forty miles an hour or more), its wind velocities exceeding 100, 200, and probably sometimes 300 or more miles an hour; its path of destruction usually less than a quarter of a mile wide; its total life a matter of perhaps an hour or so. It is as ephemeral as it is intense.

Fortunately for man, tornadoes are short-lived, have a very narrow path of destruction, and are by no means equally intense throughout their course. Their funnel cloud, which indicates the region of maximum velocity of the whirling winds, ascends and descends irregularly. Where it descends, the destruction is greatest; where it rises, there are zones of greater safety. The whirl may be so far above the ground that it does no injury whatever. It may descend low enough to tear roofs and chimneys to pieces. It may come down to the ground and leave nothing standing.

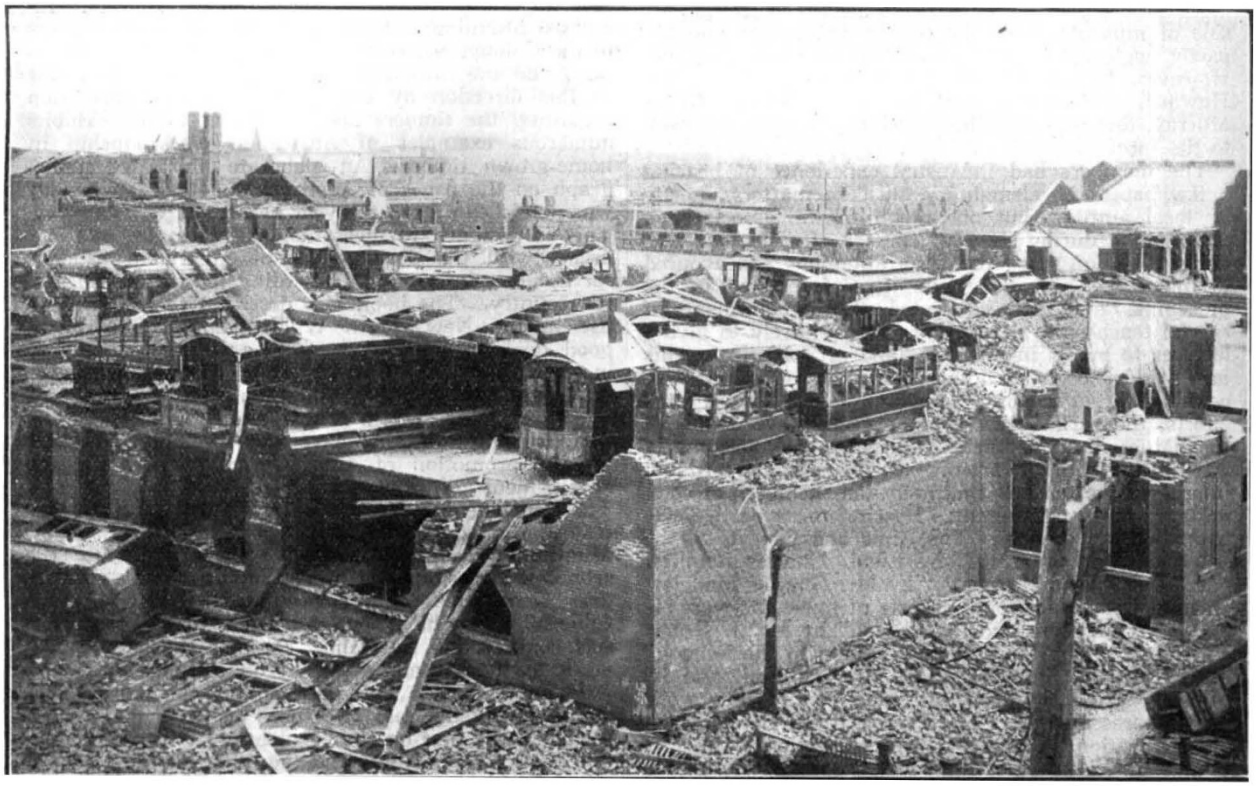

FIG. 1.—St. Louis, Mo., tornado, May 27, 1896. Wreck of Car Barn. From the Quarterly Journal of the Royal Meteorological Society.

Damage and Loss of Life in Tornadoes.—The central low-pressure core of the tornado is surrounded by radially inflowing winds of moderate strength, and then, closer to the centre, by spiralling and ascending winds of terrific violence; strong enough to crush and wreck the strongest buildings; ascending with sufficient velocity to carry aloft objects so heavy that for wind to lift them seems almost impossible. The surface winds which take part in the vorticular inflow and ascent seem to be chiefly responsible for the damage and loss of life. There is, however, an additional factor. The central "core," surrounded by its whirling winds, has its pressure greatly reduced by the centrifugal force of the whirl. It therefore exerts a powerful explosive effect upon near-by air at ordinary pressures, within buildings or in other more or less well-enclosed spaces. This curious but very widely attested explosive effect accounts for many tornado "freaks" which cannot be explained by any controls, either of radially or spirally inflowing winds, whatever their velocity.

The damage done by tornadoes may be roughly classified as follows:—(1) That resulting from the violence of the surface winds, blowing over buildings and other exposed objects, crushing them, dashing them against each other, etc.; (2) that caused by the explosive action; and (3) that resulting from the uprushing air movement close around the central vortex. Carts, barn-doors, cattle, iron chains, human beings are carried through the air, whirled aloft, and dashed to the ground, or they may be dropped gently at considerable distances from the places where they were picked up. Iron bridges have been removed from their foundations; beams are driven into the ground; nails are forced head-first into boards; cornstalks are driven partly through doors; harness is stripped from horses; clothing is torn from human beings and stripped into rags. The damage is greater and extends farther from the centre on the right of the track than on the left, for the wind velocities are greater on the right, as in the "dangerous semicircle" on the right of the track of tropical cyclones.

The explosive effects are many and curious. The walls of buildings fall out, sometimes letting the roof collapse on to the foundations; or the roof may be blown off, leaving the walls standing. The accompanying photograph (Fig. 1) illustrates some of the damage which was done by the St. Louis, Mo., tornado of May 27, 1896. The surface of the ground may be swept clean, as if with a broom. Articles may be blown out of houses and carried to great distances. Empty bottles are uncorked; feathers plucked from

barnyard poultry; doors and windows blown out; soot rises from chimneys; mud penetrates clothing.

Property damage in the United States due to tornadoes varies greatly from year to year, depending, as it does, upon the "accidental" passage of tornadoes through well-populated or through sparsely settled districts. In half an hour the St. Louis tornado (May 27, 1896) destroyed property to the amount of 10,000,000 dollars in St. Louis alone. In some years the damage for the whole United States falls to but a few hundred thousand dollars.

Fig. 2 illustrates the tragic fate of one family in a tornado (May 30, 1879).[2] A house was moved entirely from its foundation to the south-east, then broken to pieces and scattered along the tornado track to the north-east for more than a mile. The members of the household, consisting of father, mother, and four children, ran outdoors as the storm came. They first turned north-west, but, thinking that the tornado was coming towards them, they turned towards the east. One by one they were caught up and carried by the wind. The father and baby were carried 150 yards into a field to the north-east, and found in the agonies of death. The mother was carried eastward seventy-five yards, and dashed against a tree, around which she

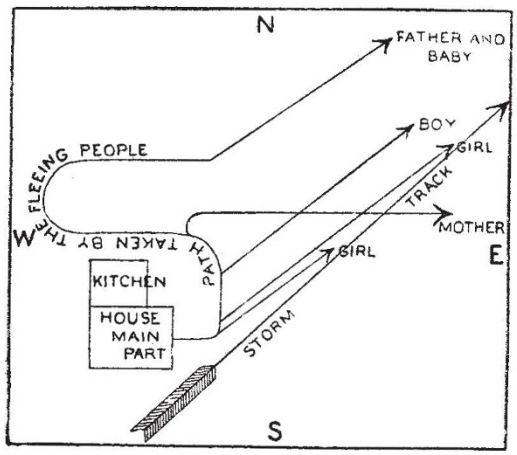

FIG. 2.—Tornado, May 30, 1879. From the Quarterly Journal of the Royal Meteorological Society.

was partially twisted; her skull was crushed, and her clothing was stripped from her body. A girl was found dead, fifty yards north-east of the house, in the direct path of the storm. A boy was blown into a haystack forty-five yards to the north-east, and a girl was found eighty yards to the north-east lying in the tornado track. Neither of these two children was seriously injured. Disasters similar to this one come all too frequently in the American tornado belt.

Finley listed some 600 tornadoes, of which forty were fatal to human life, causing a loss of 466 lives and injuring 687 persons.[3] In the case of the St. Louis tornado (May 27, 1896) the loss of life was 306. In fact, in this one storm the fatalities and the damage to property were greater than in any other single tornado on record. Prof. Mark W. Harrington, formerly Chief of the U.S. Weather Bureau, estimated that the chance that a tornado may, in any year, cross the particular locality where any individual may happen to be is 1 in 625,000, and "not worth worrying about."[4] The late Prof. Cleveland Abbe concluded that even in the so-called "tornado States" the probability of tornado destruction is less than that of lightning or fire.[5]

Distribution of Tornadoes in Place and Time.—The real home of the tornado is over the great lowlands east and west of the Central and Upper Mississippi and of the Lower Missouri valleys, and, to a less marked degree, over some of the southern States. Tornadoes are rare west of the 100th meridian, and very rare or unknown in the mountain areas. They have been reported from all States east of the plains, but decrease markedly in frequency towards the north. They are rare in the Appalachian Mountains, and also infrequent along the Atlantic and Gulf coasts. The widespread impression that tornadoes are increasing in number in the United States is without foundation of fact. Tornadoes are reported with greater accuracy than formerly, and they are likely to do more damage than they used to do because the country is more densely populated.

Tornadoes may appear in any month, and at almost any hour of the day or night. Like thunderstorms, however, they distinctly prefer the warmer months, and the hours closely following the warmest part of the day. Thus spring and early summer (April–July) and 3–5 p.m. are their favourite times.

Tornado Weather Types.—Tornadoes have much in common with thunderstorms. In fact, they are, in reality, special local developments, of greater violence, in connection with severe thunderstorms. The general conditions which produce these two phenomena are, to a large extent, identical. The essential difference comes in the formation of the vorticular whirl in the tornado. Thus, like the largest and most severe American thunderstorms, tornadoes occur as attendants of the parent cyclones of which they are the offspring. They are born, in the large majority of cases, in the area of warm, damp southerly winds flowing northward from the Gulf of Mexico in front of a general cyclonic storm. This storm is usually more or less elliptical or **V**-shaped, its major axis extending north to south or north-east to south-west from the Great Lakes, across the central lowlands well into the southern States. The "wind-shift line" or "critical axis" is usually well marked. North and west of the wind-shift line northerly to westerly winds are blowing, with relatively low temperatures, and not infrequently with rain or snow. South and east of the critical axis there is a great flow of southerly or south-westerly winds with higher temperatures, usually sultry and oppressive weather, and often with rain squalls. When conditions are favourable, tornadoes are likely to occur in a district some 300, 400, 500, or more miles to the south-east, south, or south-west of the cyclonic centre, near, but usually to the east of, the wind-shift line. Here the contrast between the warm, damp southerly and the cool, dry northerly and westerly winds is sharp. Here is inevitably a zone of great disturbance; of over-running, under-running, and mixing; of turbulence; of instability; of local whirls. Here, aided by the local warming due to sunshine, are favourable conditions for breeding thunderstorms and, fortunately much less often, for developing tornadoes. The parent cyclone may travel many thousands of miles, a good part of the way round the world, yet in only one portion of its long course, in the Mississippi valley region of the United States, and usually only at one time of the year, in spring and summer, is just the right combination of conditions attained for developing the dreaded tornado. The

[2] J. P. Finley, "Report of the Tornadoes of May 29 and 30 in the States of Kansas, Missouri, Nebraska, and Iowa," Professional Papers, U.S. Signal Service, No. iv. (Washington, D.C., 1881.)

[3] J. P. Finley, "Report on the Character of Six Hundred Tornadoes," Professional Papers, U.S. Signal Service, No. vii. (Washington, D.C., 1884.)

[4] M. W. Harrington, "About the Weather," p. 164. (New York, 1899.)

[5] Cleveland Abbe, "Tornado Frequency per Unit Area," *Monthly Weather Review*, vol. xxv., p. 250. (Washington, D.C., June, 1897.)

accompanying figure (Fig. 3) is a freehand composite illustration, showing in a broadly generalised way a weather map characteristic of tornado occurrence in the Central Mississippi valley region of the United States. Tornadoes also spring up under conditions which differ considerably from those here illustrated. It is, therefore, impossible to select or to draw any fixed "tornado-type" map.

Protection of Life.—The possible protection and preservation of human life in tornadoes are very real and vital questions over large areas of the United States. From a long and intimate study of tornadoes Finley deduced certain rules for the protection of life which have over and over again proved their accuracy and value. If a tornado is approaching, from west or south-west, and the observer is on or very near its probable path, the best thing to do, if there is time, is to run *north*. "Dug-outs" or tornado-cellars should be provided near the house. The safety secured by means of "dug-outs" is that they remove persons who seek refuge in them from risk of injury from flying *débris*, also from the danger of being picked up by the winds.

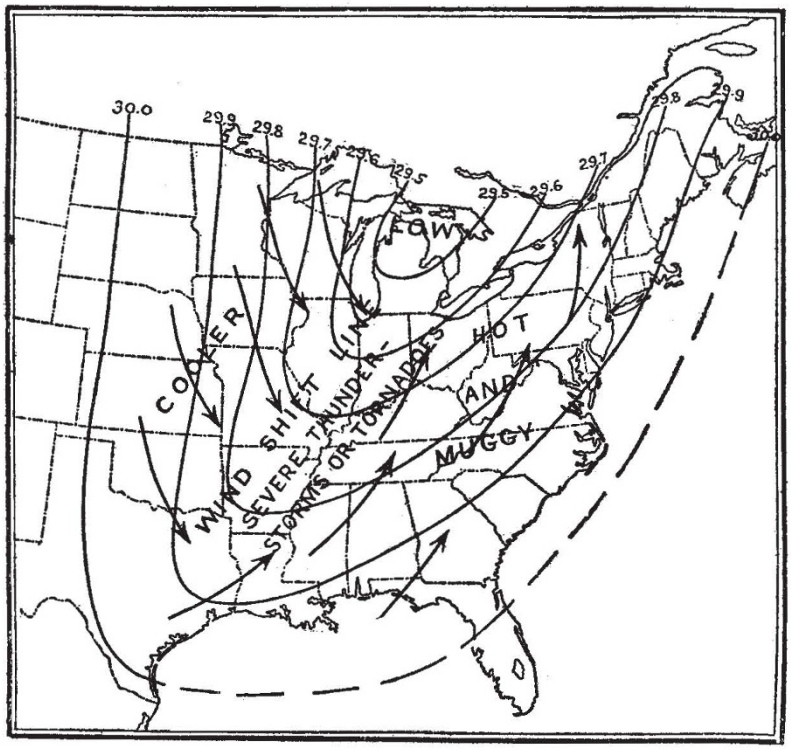

FIG. 3.—Composite weather map, showing conditions favourable for tornadoes R. DeC. Ward). From the Quarterly Journal of the Royal Meteorological Society.

If there is no time to escape, or if escape is impossible, the safest place is to stand, face forward, against the west or south wall of the cellar, as near the south-west corner as possible. The reason for these precautions is this: that the *débris* of the house will, if the building is destroyed, be most likely to be carried towards the north-east. Hence north-east or east rooms and walls are least safe. If caught outdoors, and otherwise unable to escape, the best thing to do, as a last resort, is to lie flat on the ground in an open space, face downwards, the head to the east, and the arms placed over the head for protection.

Protection of Property: Tornado Insurance.—In regard to the protection of property certain things are fairly clear. Tornadoes cannot possibly be prevented; and no building, certainly none of any practical use, can be built to withstand the violence of the wind in the vortex of a well-developed tornado. Hence the only resource left is to protect life and property to the best of our ability and with a knowledge of the facts which have been brought to light by a sane, unprejudiced, scientific study of the phenomena. Owing to the varying intensity of tornado violence and of the velocity of the surface winds, the damage done to different sorts of buildings varies greatly. If the intensity of the storm is not sufficiently great to destroy everything in its path, the damage done by the less violent winds will obviously depend largely upon the strength of construction and upon the building materials. It was Finley's advice to build "as you would without the knowledge of a tornado." He found, however, that, other things being equal, a frame building seems to resist destruction better than one of brick or stone. The modern steel-construction buildings have some of the "elastic" quality which renders frame structures safer than the more stable and solid ones of stone or brick of the older style. It makes little or no difference in the end whether a building is in a valley or on a hill.

In view of the property loss occasioned by tornadoes it is natural that tornado insurance has become a widespread and popular method of financial protection. So far, however, the business has not been carried on upon a thoroughly scientific basis. Tornado insurance to the amount of several hundred millions of dollars is carried, largely by general fire insurance companies and partly by local mutual insurance companies. The definition of a tornado is usually crude and unscientific, and there is much unnecessary confusion. It is true that the more conservative companies do prohibit some "risks," such as windmills, old and frail buildings, large plate-glass windows, and the like. It is interesting to note the marked rise and fall of the amount of tornado insurance with the occurrence in any year of severe or destructive tornadoes. Closely following the St. Louis tornado of May, 1896, there was an increase of tornado insurance of nearly 10,000,000 dollars, and after the Omaha (Nebraska) tornado of Easter Sunday, 1913, several million dollars' worth of tornado insurance was written in Omaha and the surrounding districts, which were at once thoroughly canvassed by insurance agents. Many new "dug-outs" and cellar caves were built at the same time. As Prof. H. E. Simpson [6] has pointed out, tornado insurance risks differ from others in several ways, notably in the fact that there is no criminal hazard present. For people cannot remove, or explode, or destroy their buildings for the sake of the insurance on the plea that the damage was done by a tornado. It is obviously wise to scatter tornado risks across, not along, the usual path followed by tornadoes.

[6] H. E. Simpson, "Tornado Insurance." *Monthly Weather Review*, vol. xxxiii., pp. 534–39. (Washington, D.C., December, 1905.) (A short bibliography is appended.)

The complete destruction often caused by a single tornado makes it extremely unsafe for any local mutual insurance company to insure over a small area only, where the loss occasioned by one tornado may ruin the company. On the whole, general tornado insurance in the "tornado belt," and buildings erected without regard to the possibility of tornado occurrence, seems to be the best policy. The present status of tornado insurance in the United States is an excellent illustration of the mistakes which are made when thoroughly well established scientific facts, which are easily accessible to the public, are disregarded.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Education Bill was read for a third time in the House of Commons on July 16, and will be considered at once in the House of Lords. It is expected that the Bill will be passed into law before the Parliamentary recess.

BY the will of the late Lord Rhondda the governing body of Gonville and Caius College, Cambridge, will receive out of the residue of his estate the sum of 20,000*l.*, to be applied at its discretion for the benefit of the college, but preferably in the establishment and maintenance of six to ten scholarships tenable at the college for mathematics, natural science, or moral science (including economics), preference being given, *ceteris paribus*, in the awarding of such scholarships to residents or sons of residents in Wales or Monmouthshire.

THE Industrial Reconstruction Council has arranged a series of lectures to be given at the Saddlers' Hall, Cheapside, October to December next. The lectures will be as follows:—"Commerce and Industry after the War," Sir Albert Stanley (President of the Board of Trade); "Principles of Reconstruction," Dr. Christopher Addison (Minister of Reconstruction); "Functions of the Government in Relation to Industry," Mr. W. L. Hichens (managing director, Cammell, Laird, and Co.); "International Trade," Sir Arthur Steel-Maitland (Department of Overseas Trade); "Labour and Industrial Development," Mr. Ernest J. P. Benn (chairman, Industrial Reconstruction Council); and "Science and Industry," Sir William S. McCormick (Department of Industrial and Scientific Research).

THE report of the librarian of the Congress of the United States for 1917 gives a full account of the progress of this great library. A grant of no less than 676,714 dollars was provided for the institution by Congress. The library now contains more than 2½ million volumes, besides manuscripts, maps and charts, music, and prints. Among other valuable acquisitions it contains the largest, most readily accessible, best catalogued, and most used collection in America of Chinese books. Large additions have been made to the valuable library of music. Great stores of materials for the study of social history have been brought together, including both ancient and modern political documents, such as those of Mr. Bancroft Davis, Israel Washburn, and others. The collections are splendidly housed, and the work of arrangement and cataloguing is in active progress.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 19.—Mr. G. W. Lamplugh, president, in the chair.—Sir Douglas **Mawson**: Some features of the Antarctic ice-cap. The ice-mantle of the south formerly involved the sub-Antarctic Islands, Patagonia, southern New Zealand, and the higher mountains of Tasmania and of the neighbouring portions of Australia, but it retreated to its present confines—a circumpolar continent—at a time apparently concurrent with the disappearance of the extensive Pleistocene ice-sheets of the northern hemisphere. The existence of a great land mass situated on the face of the globe just where the sun's rays fall most obliquely has the effect of intensifying the polar conditions. This result is achieved by reason of the elimination of the ameliorating influence of the ocean and as a result of the acceleration of the circulation of the moist atmosphere from the surrounding sea to the land, owing to the wide difference in temperature pertaining over the one and the other. Thus the presence of extensive land at the Pole, in contradistinction to ocean, results, under present cosmical conditions, in increased refrigeration, and consequently in greater extension of the polar ice-cap. This, in turn, reflects on the average temperature of other regions of the globe, for an ice surface absorbs but a relatively small proportion of the sun's radiant heat. The existence of the Antarctic continent must therefore have some bearing on the climate of the northern hemisphere, and be reckoned with as a factor contributing to the refrigeration thereof. The shelf-ice formations, including the Ross Barrier and the Shackleton Shelf, were specially referred to; mention was made of their growth and decline, of a method of determining their depth below water, and of the probability of specialised life existing beneath such formations.

Physical Society, June 28.—Prof. C. H. Lees, president, in the chair.—I. **Williams**: A new method of measuring alternating currents and electric oscillations. The method consists of the application of the Crookes and Osborne Reynolds radiometers to the measurement of the R.M.S. values of electric currents. Two types of apparatus are described. In the first of these the heat generated by the passage of the current through a microhm resistance causes the deflection of a light mica vane attached to the extremity of a suspended beam. In the second type the deflection of a fine fibre is employed. Tables and curves are given connecting the indications of the instruments with the current and with the degree of evacuation.—Prof. E. H. **Barton** and Miss H. M. **Browning**: Demonstration of coupled vibrations. The apparatus shown consisted of a pair of pendulums, each of which was suspended from the mid-point of a sagging string, the direction of which was transverse to the direction of oscillation of the pendulums. The two sagging strings were connected by a light wooden rod at the points from which the bobs were suspended. Each bob consisted of a metal funnel, from the apex of which a fine stream of sand fell during an experiment. A horizontal board could be moved slowly on rails just below the oscillating bobs, and the fine sand falling on this gave curves showing their motion. When one bob is set in oscillation, the other being initially at rest, the latter, as is well known, starts to vibrate with gradually increasing amplitude until the first bob has been brought to a standstill, when the process is reversed. From an examination of the equations of motion it is found that the amount of sag in the transverse strings governs the degree of "coupling" of the oscillators, and by varying this, and also the relative mass and periods of the pendulums, curves can be obtained illustrating all the phenomena of coupled electrical oscillations. By stopping one of the bobs when it has just been reduced to rest, thereby preventing the energy from being re-absorbed by it, the conditions of the quenched spark can be imitated.