though such life is neither conscious nor intelligent, it is seen to possess some quality, unknown and as yet incomprehensible to us, which is a fair equivalent for intelligence. In short it may even yet be safely said that if hundreds of volumes are required to contain our knowledge thousands would be necessary to catalogue our ignorances.

There remains then plenty of work to be done. No one who loves knowledge and is willing to work need ever want object or occupation. Nature's own operations have no more predominant characteristic than their extreme slowness, and it is not surprising that our most fruitful researches have in that respect imitated her deliberate and tentative evolutions. But it is encouraging to remember that whatever moves ceaselessly onward, losing no forward step and accumulating all its gains, must in time reach the goal. Though the masses of ignorance are still large and dark before us, knowledge does steadily accumulate on all our traversed paths. Time is long, and if we cultivate the same untiring patience which Nature has uniformly practiced in her gradual development of all things organic and inorganic, it is but a mathematical axiom that a day must come when we shall overtake her at her work—catch her, as it were, bare armed in her secret workshops, and claim undisputed heirship in all her works.

The grand results of that full and perfect knowledge which, though not for us as individuals, must come to our posterity, no mind now living can grasp or estimate. Recurring for illustration to the oft-quoted and somewhat ill-treated science of anatomy, when that day of complete and perfect knowledge shall arrive, when, for instance, our successors shall have traced out all its mysteries, localized every function, and identified every brain center and working cell, why should the future training of the individual be limited to the tedious imitative methods to which we are now confined? When with perfect knowledge we shall know how to treat all the centers of thought and will with wise discrimination, stimulating the good and repressing the bad, why should it not be possible to cultivate by unerring means intellect and even morals, to produce a great general or an honest statesman when he is most needed, to constitute a new society as superior to ours as we are to our humblest ancestors of primeval seas?

Let us not too hastily pronounce the sentence of extravagance against such hopes and speculations. To the generations of Galileo and Newton, of Laplace and Darwin, the first glimmerings of truth reached by those great leaders were equally startling. Yet in the lapse of time they have become established facts, on which the world of science plants itself with confidence as it moves forward to new conquests. Rather let us by every individual and associate effort preserve in full flower and fruit the vigor of our ancient Society as a center of continued labor. Let us encourage and stimulate each other in pressing on toward the attainment of complete knowledge. Because it is that, and that alone, which we cannot but observe, is destined to move onward and upward the world of life, and to maintain our human race in the primacy which it by no means always possessed, but is now claiming with no empty boasts.

Isaac J. Wistar.

THE GENERAL MEETING.

The first general meeting of the American Philosophical Society was held in Philadelphia on April 3, 4 and 5, 1902. Founded by Benjamin Franklin in 1743 the Society is the oldest scientific organization in America devoted to the advancement of general knowledge; and although

it has always numbered among its members many of the most distinguished scholars of this and foreign lands, no concerted attempt had heretofore been made to bring together the general membership of the Society for the presentation and discussion of scientific papers. The success of this first general meeting has been so gratifying that it is almost certain that it will not be the last of its kind. About one hundred and twenty members of the Society were in attendance upon the meetings, of whom upwards of fifty came from places more or less distant from Philadelphia.

At the annual election held on the second day of the meeting the following persons were elected to membership in the Society:

RESIDENTS OF THE UNITED STATES.

John A. Brashear, Sc.D., Allegheny, Pa.

Acting Director of the Allegheny Observatory; Fellow of Royal Astronomical Society of Great Britain; Member of British Astronomical Association; of Société Astronomique de France, etc.; maker of astronomical and physical instruments of world-wide repute.

Andrew Carnegie, LL.D., New York.

Lord Rector of the University of St. Andrew; munificent contributor to the promotion of science, learning and the useful arts; founder and endower of the Carnegie Institution, at Washington, for the promotion of original research.

Professor William B. Clark, Baltimore.

Professor of Geology, Johns Hopkins University; State Geologist of Maryland; Associate-Editor of the *Journal of Geology;* author of numerous papers in publications of United States Geological Survey and Maryland Geological Survey and in scientific journals.

Professor Hermann Collitz, Ph.D., Bryn Mawr.

Professor of Comparative Philology and German at Bryn Mawr College; author of 'Sammlung der Griechischen Dialektinschriften,' and of many valuable philological contributions.

Grove K. Gilbert, Washington.

Past-President of the American Association for Advancement of Science; Member of National Academy of Sciences; Geologist in United States Geological Survey since 1879; in Ohio Survey, 1868–70; in Wheeler Survey, 1871–4; in Powell Survey, 1875–9. Author of 'Geology of the Henry Mountains' and of numerous reports and articles in publications of the United States Geological Survey.

President Arthur Twining Hadley, New Haven.

President of Yale University; of American Economic Association; Author of 'Railroad Transportation, its History and Laws,' 1885; 'Economics—An Account of the Relations between Private Property and Public Welfare,' 1876, etc.

Professor George E. Hale, Williams Bay, Wis.

Professor of Astrophysics and Director of the Yerkes Observatory, University of Chicago; author of many valuable papers on the sun, stellar spectroscopy, etc.

Professor Paul Haupt, Baltimore.

Professor of Semitic Languages in Johns Hopkins University; editor of the 'Polychrome Bible'; author of 'Sumarisch-Akkadische Keilschrifttexte,' 'Sumarische Familiengesetze,' 'die Akkadische Sprache,' etc., and of numerous papers on Biblical and Assyrian philology, history and archeology.

C. Hart Merriam, Washington.

Chief of the United States Biological Survey, Department of Agriculture; one of the most eminent of America mammalogists; author of several works and numerous papers on zoological and botanical subjects.

Professor Albert Abraham Michelson, Sc.D. (Cantab.), Chicago.

Head Professor of Physics in University of Chicago; Member of National Academy of Sciences; Fellow of Royal Astronomical Society; author of numerous valuable papers chiefly on researches in light.

Professor Theodore William Richards, Cambridge, Mass.

Professor of Chemistry in Harvard University; Member of National Academy of Sciences. Author of numerous papers concerning atomic weights and physical chemistry.

Professor Felix E. Schelling, Ph.D., Philadelphia.

Professor of History and English Literature in University of Pennsylvania; author of 'English Chronicle Plays'; editor of 'Book of Elizabethan Lyrics'; 'A Book of Seventeenth Century Lyrics'; etc.

Professor Robert Henry Thurston, Ithaca.

Professor of Mechanical Engineering, Stevens' Institute, 1871–85; Director of Sibley College, Cornell University, since 1885; first President of American Society of Mechanical Engineers; inventor of various valuable mechanical devices; author of about 20 volumes and some 300 scientific papers.

Benjamin Chew Tilghman, Philadelphia.

Manufacturing chemist and student of chemistry and physics; author of a monograph (as yet unpublished) on the chemical changes undergone by bones in passing from the living to the fossil condition.

Professor Robert S. Woodward, New York.

Professor of Mechanics in Columbia University; mathematician and astronomer of recognized eminence; Past-President of the American Association for Advancement of Science; President of American Mathematical Society, 1898–1900; Member of the National Academy of Sciences; author of numerous scientific papers on geodetic and astronomical topics.

FOREIGN RESIDENTS.

Antoine-Henri Becquerel, Paris, France.

Member of the Institut de France—Académie des Sciences; the third in descent of the French physicists of the name who have made themselves famous by their researches in science; his work has been chiefly in optics and magneto-optics; he discovered the uranium emanations, now called by his name, which led to the discovery of radium.

Jean-Gaston Darboux, Paris, France.

Perpetual Secretary of the Académie des Sciences—Section of Mathematics; eminent mathematician and author of numerous valuable papers on that subject.

Sir Michael Foster, F.R.S., D.C.L., Cambridge, Eng.

Secretary of the Royal Society; Professor of Physiology at Cambridge; Honorary Perpetual President of the International Congress of Physiologists; Chairman of the International Council in charge of the International Catalogue of Scientific Literature; President of British Association for Advancement of Science, 1899; author of 'Text-Book of Physiology,' and of other works; Joint-Editor of 'Scientific Memoirs of Thomas H. Huxley.'

Professor G. Johnstone Stoney, F.R.S., London, Eng.

Graduate of the University of Dublin and Fellow of Trinity College; formerly Astronomical Assistant to the Earl of Rosse, at Parsonstown, and subsequently Professor of Natural Philosophy in Queen's University; his papers upon the 'Physical Constitution of the Sun and Stars,' on the 'Internal Motion of Gases,' on 'Spectroscopy and Microscopy' have attracted universal attention.

Professor Silvanus P. Thompson, F.R.S., London, Eng.

Principal and Professor of Physics in City and Guilds Technical College, Finsbury; a well-known investigator in physics and an authority on electrical subjects; author of sundry technical works on electricity, and of 'Lectures on Light, Visible and Invisible.'

The sessions of the general meeting began on Thursday morning, April 5, in the historic hall of the Society in Independence Square, with an address of welcome by the president of the Society, General Isaac J. Wistar, in which he pointed out the broad and liberal character of the Society as indicated by the plans of its founder and the subsequent history of the Society, and also the important part which the Society has taken in the 'promotion of useful knowledge.' This address, which will be published in full elsewhere, was followed by the presentation of the following scientific papers, most of which will appear in the *Proceedings* and *Transactions* of the Society:

Professor John B. Hatcher, of Pittsburgh, in a paper on the 'Origin of the Oligocene and Miocene Deposits of the Great Plains,' called attention to the great deposits of bones at various localities in the White River beds. He described them as literally covering the ground in places where they have weathered out over areas frequently of more than an acre in extent. It is not only difficult, but Professor Hatcher thinks impossible, to account for these accumulations of bones of terrestrial animals at the bottom and in the very

middle of a great lake. Since the surrounding clays are usually almost destitute of bones, it is difficult to understand how the dead carcasses of so many animals were driven or drawn as by a magnet to so limited an area. Accepting the other theory, however, we have seen how, during the rainy season, the deer, tapirs and other animals are driven to the islands over the flood plains of the great South American rivers. Since in exceptionally high freshets the lower of these islands become destroyed, it is not difficult to understand how great numbers of these animals must annually perish, and indeed it is a well-known fact that frequently great numbers of them are caught on low islands and, driven by the rising waters to more limited confines, they are finally all drowned when the island becomes entirely submerged. To such or similar conditions the great deposits of bones in the Oligocene and Miocene deposits of the West may owe their origin.

These facts, together with those brought forward by Dr. Matthew in his article 'Is the White River Tertiary an Æolian Formation' (*Am. Naturalist,* May, 1899), have driven Professor Hatcher, contrary to his earlier opinion, to reject the theory of a great lake and accept that of small lakes, flood-plains, river channels and higher grass-covered pampas as the conditions prevailing over this region in Oligocene and Miocene times.

MR. EARL DOUGLASS, of Princeton, in a communication on 'The Upper Cretaceous and Lower Tertiary Section of Central Montana,' pointed out that the finely exposed section of Cretaceous and Lower Tertiary rocks near the Musselshell River in Montana has been considerably affected by the disturbances that produced the mountains a little farther to the westward, so that erosion has exposed the different formations from what is apparently the Jurassic to the Torrejon. He maintained, (1) that there are beds below the Fort Pierre, which have Laramie flora and fauna; (2) that the Livingston, Arapahoe and Denver beds correspond in age with the upper portions of what has been called Laramie; and (3) that the Fort Union beds are of the same age as the Torrejon in New Mexico.

PROFESSOR W. B. SCOTT, of Princeton, in a paper on 'South American Mammals,' confined his remarks to the Edentata of the Santa Cruz (Miocene) beds of Patagonia. Very curious is the absence from these beds of the existing families of the ant-eaters and the true or arboreal sloths, while armadillos, glyptodonts and ground-sloths are most abundantly represented. The armadillos are nearly all of aberrant type and very peculiar in some respects; only one species seems to be ancestral to a species of modern times.

The glyptodonts are very small and in remarkable contrast to the giant forms of the Pleistocene.

The ground-sloths are relatively small, as compared with the huge representatives of this group which in Pleistocene times spread over nearly the whole of North and South America. In the Santa Cruz beds are found the probable ancestors of nearly all the Pleistocene genera. Of especial interest on this occasion is the newly discovered genus which seems to be the ancestor of *Megalonyx*. The latter was first discovered by President Thomas Jefferson and described in an early volume of the *Transactions* of this Society.

SAMUEL N. RHOADES, of Audubon, N. J., in a paper on the 'Mammals of Pennsylvania and New Jersey,' said that Pennsylvania and New Jersey, on account of their geographic position and the consequent variety of the faunal environments afforded by the two extremes of the elevated Alleghanian summits and the sandy maritime plains of the southeastern coast line,

present a relatively large and varied list of land and sea mammalia. These number in existing native species and races ninety-five, of which seventy-seven are terrestrial or amphibious, and eighteen are aquatic.

The extinct mammalian fauna of the two states is remarkably large, exceeding greatly that of the entire remainder of the United States east of the Mississippi River. Of extinct terrestrial mammalia there have been described, mainly from the limestone bone caves and fissures of the Pleistocene horizon in the lower Delaware Valley, ninety-one species. These include such tropical genera as the giant sloth, rhinoceros, tapir, elephant, manatee and saber-toothed tiger, as well as arctic forms now only existent in Canadian regions, such as the reindeer, moose, musk ox and walrus. From the marl beds of New Jersey nine species of whales, referable with one exception to the tropical shark-toothed family now existing in the Indian Ocean, have been described.

Comparing the two lists, the remarkable fact is shown that in Pennsylvania and New Jersey the list of extinct species of mammals known to us equals, if not exceeds, that of the existing species. In contrast to this New York in Miller's recent list only boasts of five species of known extinct mammalian species.

The effect of deforestation by axe and fire, and its consequent radical alteration of climatic conditions even in the most inaccessible parts of the Alleghanian wilderness at the present day, has done much more to alter the faunal status than all other destructive agencies combined. In consequence many of the least known of the smaller mammalia approach extinction. Of the larger, the native wapiti, bison, beaver, cougar, wolf and wolverine, some of which lingered far into the last century in Pennsylvania are now exterminated.

Dr. Frederick W. True, of Washington, in a communication on 'The Identity of the Whalebone Whales of the Western North Atlantic,' summarized the results of an extensive investigation of the whalebone whales of the Atlantic coast of North America carried on under the U. S. National Museum, the principal object being to ascertain whether the species which occur in American waters are the same as those known to frequent the coast of Europe, and thus to provide a more trustworthy basis for the study of the geographical distribution of these animals. The American species were found to be the same as those of Europe, but the European finback whale known as Rudolph's Rorqual, *Balænoptera borealis* Lesson, has not been found in American waters. The species occurring on the east coast of North America are as follows:

Greenland whale or Arctic right whale, *Balæna mysticetus* (L.).

Black whale, or the right whale of the Temperate North Atlantic, *Balæna glacialis* (Bonnaterre).

Humpback, *Megaptera nodosa* (Bonnaterre).

Common finback, *Balænoptera physalus* (L.).

Sulphurbottom, *Balænoptera musculus* (L.).

Little piked whale, or lesser finback, *Balænoptera acutorostrata* (Lac.).

AFTERNOON SESSION.

Professor H. von Ihering, of São Paulo, Brazil, in a paper on the 'Molluscan Fauna of the Patagonian Formation,' which was presented by Professor W. B. Scott, described two of the most striking of the many new species contained in the large collection made under his direction.

Professor Edward S. Morse, of Salem, Mass., in a 'Comparison between the Ancient and Recent Molluscan Fauna of New England,' said that the results of observations and measurements of the species of shells found in the shell heaps of New England, in comparison with the shells of the same species found living to-day in close proximity to the deposits and presumably

their descendants show in every case a change in the proportionate diameters. As an illustration, the common clam, *Mya arenaria,* found in the shell heaps has a greater height in proportion to its length than that of the recent forms. This index is higher north of Cape Cod, both in the ancient and recent. The same differences are found in Japan and in England. The index is very much higher in the glacial deposits. For this and other reasons the change in the index is correlated with temperature.

It is furthermore pointed out that related forms in Japan and New England had changed in precisely the same manner. Full details with tables of measurements will be given in the memoir on the subject.

PROFESSOR ARNOLD E. ORTMANN, of Princeton, in a paper on the 'Distribution of Fresh Water Decapods and its Bearing upon Ancient Geography,' said that the present and former distribution of these animals suggested the following land connections in former times:

1. Northeastern Asia with northwestern America, across Bering Sea.

2. East Asia (Sinic Continent) with Australia, over the Malaysian islands.

3. South Asia and Africa, by way of Madagascar.

4. New Zealand with Australia, by way of New Caledonia and New Guinea.

5. Australia with Antarctica, and Antarctica with South America (Archiplata).

6. The Greater Antilles with Central America.

7. Africa with South America (Archibrazilia).

PROFESSOR W. M. DAVIS, of Cambridge, in a paper on 'Systematic Geography,' said that the accumulation of an ever-increasing store of facts under the broad subject of geography makes it desirable to establish a classification with respect to which the facts may be arranged, not only for the convenience of putting them away in good order and of readily finding them again when wanted, but even more for the sake of the better understanding that comes from association and correlation. Geographical classification may be by kinds or by places, systematic or regional; but the first should precede the second. The first provides a scheme whereby all similar items, whatever their place of occurrence, may be brought together under a single category; the second describes all the items of a certain region as examples of known categories, and presents them in an order that expresses their systematic relationships. There is to-day no precise agreement as to the total content of geography, much less as to the subdivision and systematic arrangement of its parts; but if the study of the earth in relation to its inhabitants be taken as a sufficient definition of the subject, its prime divisions must be the physical environment of organisms and the responses of the organisms to their environment. Each of these divisions is then to be subdivided into many categories, and each category is to be rationally described, to be illustrated by typical examples, and to be traced through its relationship to the categories of the other prime divisions of the subject. The innumerable relationships thus disclosed constitute the subject of geography proper, and it is as an aid to their systematic treatment that the proposed classification of the subject as a whole is undertaken.

MR. HENRY G. BRYANT, of Philadelphia, in his paper entitled 'Drift Casks in the Arctic Ocean,' gave the present status of an experiment worked up by Admiral George W. Melville, U. S. N., and himself, which aimed to test the speed and direction of Arctic currents by means of a series of drift casks set adrift in the Arctic Sea north of Alaska. He called attention to the fact that the scheme was the outcome

of the Nansen Meeting of the American Philosophical Society held in 1897, on which occasion Admiral Melville called attention to the feasibility of a plan to ascertain the speed of ocean currents in the circumpolar regions by setting adrift a series of especially constructed, spindle-shaped casks in the waters north of Bering Strait and in other parts of the Arctic Ocean.

This proposed method of studying Arctic currents without endangering human life was brought to the attention of the Geographical Society of Philadelphia and that body determined to undertake the project. Fifty casks of special shape, to escape crushing by ice pressure and covered with a coating of black water-proofing material were made in San Francisco. Messages printed on linoleum paper by a permanent blue-print process, which renders them impervious to salt water, were provided. These messages were printed in the English, Norwegian, German and French languages and embodied the following particulars: (*a*) Name of vessel and master assisting in the distribution, date, number of cask and latitude and longitude of point where it was set adrift; (*b*) direction as to filling in record and sealing up tube; (*c*) blank space for insertion of name of finder, date and locality where cask was picked up; (*d*) clause requesting finder to notify the nearest U. S. Consul or to send direct to the Geographical Society of Philadelphia. Accompanying each consignment of casks was a set of printed instructions to masters of vessels engaged in their distribution.

In the hazardous work of distributing the casks assistance was rendered by the U. S. Revenue Cutter *Bear* and the vessels of the whaling fleet sailing from San Francisco. Mr. Bryant stated that reports of the accomplishment of the preliminary work have come in rather slowly, owing to the length of the whaling voyages. The work of distribution had begun in 1899 and reports were still coming in from the whaling captains. To date, thirty-five casks had been launched in the far North and fifteen remained yet to be heard from.

It has been known for years that no appreciable amount of water from the polar ocean escaped through the narrow, shallow outlet of Bering Strait, while the knowledge gained from the drift of the *Jeannette* and *Fram* points to the existence of a well-defined drift across the circumpolar area to the shores of Franz Joseph Land, Spitzbergen and East Greenland. The presence of quantities of Siberian driftwood in the localities named can be explained by no other intelligent hypothesis, while it is well known that Dr. Nansen based the theory of his voyage primarily on the finding of the *Jeannette* relics on the west coast of Greenland, three years after the crushing of that vessel in the sea northeast of the New Siberian Islands.

From the nature of the case, it is difficult to prophesy the time that will be required to complete the drift, but it is safe to assume that from three to five years will be required by the casks to make the journey across the polar basin.

Mr. Joseph Wharton, of Philadelphia, speaking of 'The Magnetic Properties of Nickel,' said that this metal is capable of being made permanently magnetic. He made a horseshoe magnet and ship compasses of nickel for the Centennial Exposition of 1876, and sent compasses to the American, British, French and Russian governments for experiment on shipboard. The United States and English officials paid no attention to the matter, but the other countries named made official investigations, indicating, among other things, that pure nickel shows a very considerable permanent magnetism—about one half as much as hardened steel.

In the evening session, President HENRY S. PRITCHETT, of the Massachusetts Institute of Technology, spoke on 'The Relation of the American University to Science,' and President DANIEL C. GILMAN, of the Carnegie Institution, on 'The Advancement of Knowledge by the Aid of the Carnegie Institution.' These addresses were followed by a public reception at the Museum of Science and Art, given in honor of the members of the Society by the Department of Archeology of the University of Pennsylvania.

FRIDAY MORNING SESSION.

PROFESSOR T. J. J. SEE, of Washington, in a 'Historical Investigation of the Supposed Changes in the Color of Sirius since the Epoch of the Greeks and Romans,' pointed out that the highest authorities of antiquity attributed to Sirius a ruddy color, and that there is no authority who says that the star was white, and that it has become white since the time of the Roman emperors—perhaps since the end of the fourth century. The star may have changed color very suddenly, or its redness may have gradually faded with the centuries and disappeared slowly like the ancient civilization. In modern times the star has always appeared white, and there is therefore no suspicion that the color changes periodically. The redness of a star's light depends, without doubt, mainly upon selective absorption; accordingly, the natural explanation of this change of color would seem to be a change in its atmosphere.

PROFESSOR ERNEST W. BROWN, of Haverford, Pa., in a paper on 'Recent Progress in the Lunar Theory,' gave a general account of the lines along which investigation has proceeded during the last thirty years. The work of Dr. G. W. Hill on periodic orbits was the starting point of the investigation undertaken by M. Poincaré. The investigations of the latter on divergent series were also referred to. The second part of the paper contained an account of the progress made towards verifying the law of the inverse square. The writer also gave an account in some further remarks of the progress made in the theory which he is now working out. He pointed out in what way it might settle some outstanding difficulties.

PROFESSOR M. B. SNYDER, of Philadelphia, in a paper 'On a new Method of Transiting Stars,' described a method of driving the ordinary micrometer screw of the transit instrument by means of a small electric motor to the speed pertaining to any given declination, at the same time that the observer by a secondary adjustment of the position of the wire secures and maintains bisection of the star, and an automatic record of given positions of the screw is made on a chronograph. The Repsold method of alternately twirling the screw of a specially constructed micrometer was held to be radically defective in important particulars. Various devices for accomplishing the electrical method of driving and of regulating the motion of the screw of the transit micrometer, as well as the actual arrangement in use at the Philadelphia Observatory, called for brevity a 'transiter,' were described. The transiter seemed to furnish all the necessary facilities of motion and of recording, and not only permitted elimination of all errors excepting that of bisection, but for the first time allowed of the direct determination of absolute personal equation upon the stars themselves at all transits where this might be desired.

MR. PERCIVAL LOWELL, of Flagstaff, Ariz., spoke on 'The Evolution of Martian Topography.' He said that one of the great causes of misapprehension and contradictions in former observations of Mars is that the planet looks differently in winter and summer. The dark patches

were called seas, but it has been found that there are no seas on Mars. There are no large bodies of water, and the question is: Are there even small ones? The surface is vastly different from that of the earth, in that it is apparently all land, but there is a strange similarity in the air currents.

He described the investigations of Schiaparelli and others and deduced evidence that the so-called canals are vegetation.

Mars is passing, like the earth and the moon, through a process of drying up. It is not as far advanced as the moon, where there is no moisture or atmosphere, but it is farther advanced than we are.

Professor Chas. L. Doolittle, of Philadelphia, presented a paper on 'Results of Observations with the Zenith Telescope at the Sayre Observatory.' In 1876 was begun at the observatory erected by Robert H. Sayre at South Bethlehem, Pa., a series of 'Latitude Observations' which was continued with considerable interruptions until August 19, 1895. The final results of the latter part of this series, from January 19, 1894, till the close, were published in full about one year ago.

The present communication, which concerns the earlier portion of this work, comprised three sections or subdivisions.

1. Investigation of the right ascensions and declinations of the stars employed in the latitude work—254 in all.

2. Results of latitude observation from 1876 to 1891—2,623 determinations.

3. Results of observations from October 10, 1892, to December 27, 1893—2,900 determinations.

In section 2 the latitude determinations discussed are distributed very unequally through the years 1876, '77, '78, '85, '86, '88, '89 and '90. With the exception of those of 1889–90, they are not well adapted to an investigation of the periodic changes of the latitude.

The investigation of the constant of aberrations was contemplated in planning the work of 1889–90 and that of 1892–93, though it was at that time regarded as a kind of by-product. Each observation furnishes one equation for this purpose. The 2,900 equations of the latter series were combined by a process of 'bunching' to form 190 separate equations, which were solved in the usual way, giving for the aberration constant the final value

$$20.''551 \pm .009.$$

A peculiar feature of the latitude values is a progressive diminution of the mean value.

Thus we have the following mean results:

1876–78 Latitude =	40°	36′	23.81″
1889–90	40°	36′	23.41″
1892–93	40°	36′	23.11″

No satisfactory explanation of this apparent diminution has been found.

Professor John Trowbridge, of Cambridge, presented an interesting paper on the 'Spectra of Gases at High Temperature,' which was illustrated by a series of lantern slides. He called attention to his discovery of dark lines in the spectra of gases not due to absorption, which do not change the silver salt and which give therefore bright lines on the negative. This shows that there are rates of vibration to which the photographic plate does not respond. This discovery leads us to believe that the solar spectrum is probably far more complex even than we have supposed.

AFTERNOON SESSION.

Professor A. Stanley Mackenzie, of Bryn Mawr, presented a paper, entitled, 'On Some Equations Pertaining to the Propagation of Heat in an Infinite Medium,' in which attention was called to the necessity of trying to interpret in terms of physical conceptions all the mathematical

operations used in the analytical treatment of physical problems. The inherent physical meaning of each step in the treatment should be made evident, and the general nature of the result of each step should be capable of prediction; this may not always be possible, but it is rather more common than not, to avoid such interpretations. The paper dealt with these points as illustrated in the study of heat conduction (or in cabling), and pointed out the importance of that subject for its pedagogical value in mathematical physics. Beginning with the solution for the periodic distribution of temperature about a point, the solutions for other problems were built up, each step in the analysis being first discussed as to its physical interpretation, and the relationships of the various solutions brought out. In this way was developed the meaning of many of the common operations involved, the possibility of their being solutions, and finally the interpretation of a Fourier's integral. Among other things, careful drawings were exhibited of the curves for temperature and current for the more important equations.

PROFESSOR M. I. PUPIN, of Columbia University, New York, in a paper on 'The Law of Magnetic Hysteresis,' presented an account of a mathematical and experimental research upon the magnetic properties of iron which resulted in the discovery of a new law in magnetism. This law can be stated as follows:

"The heat generated per unit volume of iron during a cycle of magnetization is proportional to the cube of magnetic intensity."

This law holds true within the first of the three well-known intervals of magnetization. It was discovered by determining accurately the resistance of the magnetizing helix, employing vibratory magnetizing forces of about 1,000 periods per second, and then separating the various components of this resistance by means of mathematical analysis.

This investigation is an extension of the researches of Professor Ewing of Cambridge University, England, and of Lord Rayleigh, employing a new and very much more sensitive method. Its results have a very important practical bearing in the manufacture of inductance coils. From its purely scientific aspect the new law derives its principal interest from the fact that it will materially assist in the formulation of the physical theory of magnetism.

PROFESSOR W. K. BROOKS, of Baltimore, presented a one-minute paper on the subject 'Is Scientific Naturalism Fatalism?' It is impossible to fairly report this paper, already admirably condensed, without presenting it in its entirety. It may be said, however, that, basing his opinion on well-known views of Hume and Berkeley, the author maintained that certainty in the natural world does not imply necessity in the agent.

Professor Brooks also presented a paper, illustrated by drawings and models, on '*Dichotoma*, a New Genus of Hydroid Jelly-fish,' found in the Bahamas, which shows many resemblances to a fossil form described by Walcott from the Lower Cambrian.

PROFESSOR HENRY KRAEMER, of Philadelphia, in a paper 'On the Continuity of Protoplasm,' which was illustrated by lantern slides, said that a starch grain consists of alternate layers of colloidal and crystalloidal substances, and that the colloidal layers are the ones which take up the various aniline dyes, as gentian violet, eosin, safranin, etc. The various clefts and fissures produced in the grains behave toward staining reagents much like the colloidal layers, and they are probably the tracts or channels through which liquids are distributed throughout the grain. The author has observed that by the use of

various swelling reagents a similar layering is produced in the walls of endosperm and stone cells and that the structure is physically quite similar to, although chemically different from, that of the starch grain.

In continuing these observations on the cell wall, using staining agents in connection with swelling substances, including sulphuric acid, the author finds a close similarity in the appearance produced in the thick-walled endosperm cells in the date, vegetable ivory and nux vomica, and is inclined to consider that the appearance produced in the walls of these and other cells, which has given rise to the widespread conclusion that it indicates a continuity of protoplasm, has a close relation to the colloidal layers and clefts in the starch grain which take up staining reagents. Furthermore, the protoplasm in the cells of vegetable ivory is frequently stained an entirely different color from that of the so-called threads of protoplasm. In nux vomica the threads are interrupted and in vegetable ivory they are peculiarly curved, indicating an alteration of the cell wall, which condition is very pronounced in some of the thinner sections.

Professor Edwin G. Conklin, of Philadelphia, presented, with lantern slide illustrations, a brief synopsis of a paper on the 'Embryology of a Brachiopod, *Terebratulina septentrionalis*.' The early development of this animal is unlike that of annelids and mollusks, though the larvæ belong to the Trochophore type. The larvæ of this brachiopod closely resemble those of *Phoronis* and show certain likenesses to the Polyzoa. All three of these groups should be classed together in a phylum distinct from the Annelida, Mollusca or Chætonatha.

Professor Thos. H. Montgomery, Jr., of Philadelphia, presented in a paper on 'The Relationship of the Gordiacea,' a brief abstract of an anatomical memoir on the genus *Paragordius*. The conclusion reached from a study of the adult structure is that the Gordiacea are neither Annelida nor Nematoda, but in most points of structure appear to represent a phylum distinct from both of these.

Dr. M. Louise Nichols, of Philadelphia (introduced by Professor Conklin), presented a brief synopsis of a paper on the 'Spermatogenesis of *Oniscus asellus*, with especial reference to the History of the Chromatin.' The first of the two maturation divisions in this animal is reducing. The spermatids become associated in groups to form sperm colonies, each of which is flagellate at its anterior extremity.

Dr. Cyrus Adler, of Washington, presented a communication on the plans and purposes of the 'International Catalogue of Scientific Literature,' and exhibited advanced sheets of one of the volumes now being published.

SATURDAY, APRIL 5.

Professor Lindley M. Keasbey, of Bryn Mawr, in a paper entitled 'A Classification of Economies,' defined an economy as a system of activities whereby the potential utilities inherent in the environment are, through utilization, converted into actual utilities. In working out a classification, economies, he said, can be distinguished from each other in two ways: Subjectively, according to the incentive leading to utilization, and objectively, according to the means employed in the process. Applying this canon of distinction, we can distinguish between the *automatic economy* characteristic of plant life, the *instinctive economy* characteristic of animal life, and the *rational economy* characteristic of human life. The course of human development also exhibits three characteristic types of economies: First the *acquisitive economy*, where the motive making for utilization is

the acquisition of use values, and the means employed in the process consist of artificial implements that can be worked with the hand. Second, the *proprietary economy,* where the motive is to add to one's possessions or acquire proprietary values, and the means employed in the process consist of agricultural capital, *e. g.,* domesticated herds and cultivated fields. Third, the *commercial economy,* where the motive is the acquisition of exchange values, and the means employed in the process consist of industrial capital, *e. g.,* buildings, shops, ships, machines, etc.

For each of these three types of economies there is a corresponding organization of industry. The organization adapted to the acquisitive economy is cooperative; that adapted to the proprietary economy is coercive; and that adapted to the commercial economy is competitive.

Having established the three fundamental types of economies, the classification may be carried further by taking the several processes of production and the several systems of distribution and exchange into account.

DR. SIMON FLEXNER, of Philadelphia, reported upon some 'Experiments in Cytolysis.' There has been great activity, he said, in the study of the conditions under which tissue and blood cells undergo solution. For the blood cells it has been demonstrated that various agents—chemical, physical and biological—bring about solution—the so-called hæmolysis. The first two agencies act by disturbing osmosis within the cells; biological solution —that produced by foreign blood sera—is produced through a fermentative action (Ehrlich) in which two sets of substances are required. The substances are denominated intermediary body (receptor) and complement, and are normally present in active sera. Should the intermediary body (receptor) be absent, it can be produced by the treatment of animals with blood cells in a manner analogous to the immunization to bacteria. Similar intermediary bodies capable of uniting with appropriate complements can be produced for most or all body cells. In that they are destructive for the specific cells through which they have been produced, they are termed 'cytotoxins.' The most active are the heterocytotoxins, produced in alien animals; but less active isocytotoxins are known and in a few instances autocytotoxins for blood cells have been produced. Hitherto the study of the histological changes produced by cytotoxins has been little pursued. The author has prepared cytotoxins for lymphatic gland cells and injected the product into animals of the class from which they were prepared, with the result of causing definite histological changes in the corresponding tissue. The changes consist of necrosis and multiplication of the cells of the germinal centers, giving rise to appearances indistinguishable from those produced by well-known bacterial toxins, such as the toxins of the diphtheria bacillus and streptococcus, and the toxins ricin and abrin derived from the higher plants.

PROFESSOR A. C. ABBOTT, of Philadelphia, presented a paper prepared by himself and Dr. D. H. Bergey, on 'The Influence of Alcoholic Intoxication upon Certain Factors concerned in the Phenomena of Hæmolysis and Bacteriolysis.' The authors' experiments indicate that the increased susceptibility to infection seen in alcoholized rabbits is, in part at least, explainable through a reduction in the amount of 'protective proteids,' normally present in the blood. They found the power of restoring to a heated immune serum its hæmolytic property to be from fifteen to twenty-five per cent. less in the serum from alcholized than in that from normal rabbits. This they interpret as a

reduction of the usually present ferment-like 'complement' of Ehrlich and Morgenroth, a body regarded by those authors as essential to the mechanism of vital resistance to infection.

Professor J. C. Wilson, in a paper on 'Osteitis deformans,' communicated some facts in regard to this rare disease which was first described by Paget in 1877. He thought it might be due to (1) infection by some organism to the action of which bone tissue is especially liable, or (2) to the default of some physiological principle which normally regulates and limits the growth of bone. Either of these views may serve as a working hypothesis for investigations into the causes of the disease.

Professor Lewis M. Haupt, of Philadelphia, a member of the Isthmian Canal Commission, presented a paper, fully illustrated by lantern slides, on the proposed 'Isthmian Canals.'

Professor M. D. Learned, of Philadelphia, presented the final paper of the meeting on 'Race Elements in American Civilization and an Ethnographical Survey of the Country.' This paper presented in condensed form the importance of a thorough investigation of the race elements in our American life and institutions, with illustrations from the influence of the German element upon American agriculture, industry, trades, commerce and particularly upon our educational and scientific methods, our social and economical life and our art and literature.

The plan of an 'Ethnographical Survey' has already assumed practical form, and an expedition is being equipped for the coming vacation. The work will furnish data of wide range, on the survivals of early German culture, the architecture, geographical distribution, migration of early settlers and the present economic, sociological, industrial and other cultural conditions of the German element.

The social features of the meeting were most enjoyable. Luncheon was furnished at the hall of the Society on Thursday and Friday and many opportunities were afforded for making and renewing acquaintances. On Thursday evening a largely attended reception was given in honor of the members of the Society at the University of Pennsylvania. On Friday evening the visiting members were the guests of the resident members at dinner at the Hotel Bellevue on which occasion one hundred and eighteen members were present. At the close of the dinner Professor W. B. Scott, acting as toastmaster, introduced in happy vein the persons named below, who responded ably and delightfully to the following toasts: 'The Memory of our Founder,' Mr. Samuel Dickson; 'Our Sister Societies,' Professors Edward S. Morse and J. McKeen Cattell; 'Our Universities,' President Francis L. Patton and President Ira Remsen; 'The Future of Science,' Dr. Wm. Osler; 'Our Guests,' Professor H. Morse Stephens.

At the close of his remarks Professor Stephens proposed a toast to 'The Health and Continued Prosperity of the American Philosophical Society,' in which all present joined.

OUR SISTER SOCIETIES.*

I realize the honor of being asked to respond for the National Academy of Sciences to the toast 'Our Sister Societies.' In a sense the National Academy of Sciences may be considered more intimately related than a sister, for on its organization and incorporation by the National Government in 1863 we find among its fifty members forming the corporate body the largest number from any one place were

* Speech at the dinner on the occasion of the recent general meeting of the American Philosophical Society.