ents; the mean heights of clouds from different directions; the mean velocities and frequencies of the clouds at different heights; the frequencies of the different currents at different heights, etc. The mere enumeration of the headings of these tables will suffice to show the thoroughness of the work discussed in this volume—a thoroughness which is characteristic of all of Mr. Clayton's cloud studies. The text accompanying the tables discusses the methods of measurement and of computation employed, and the meteorological results of the investigation. It is impossible to present any adequate summary of the important results reached by Mr. Clayton. Those who seek further information should turn to the volume itself, which is worthy of careful study. There is, however, one point which we would notice here. From a series of special measurements of cumulus and fracto-cumulus clouds, made with a view to determining the relation between the heights of these clouds as obtained by theodolites and from the dew-point, it appears that turreted cumulus clouds are most frequent at the coldest time of day, and not at the warmest, as is the case with ordinary cumulus. Thus, as Mr. Clayton points out, it seems that the diurnal period of the turreted cumulus is not determined by heating at the ground but by cooling at the surface of the cloud. The turreted cumulus probably forms only when the decrease of temperature from other causes approaches the adiabatic rate. It is thus an indication of thunderstorms, for a rapid vertical decrease of temperature in the upper air, when combined with a rapid decrease in the lower air caused by heating at the ground, favors the ascent of columns of air from the ground, to great heights and this is a condition favorable to thunderstorms.

The present volume is fully worthy to take its place in the line of Blue Hill Observatory publications as another important American contribution to meteorology.

R. DeC. Ward.

BOOKS RECEIVED.

Text-Book of Paleontology. Karl A. von Zittel. Translated and edited by Charles R. Eastman. London and New York, The Macmillan Company, 1900. Pp. ix + 706.

Volumetric Analysis. John B. Coppock. London, Whittaker & Co.; New York, The Macmillan Company. 1900. Pp. 92.

The Soul of Man. Paul Carus. Chicago, The Open Court Publishing Company. 1900. Pp. xviii+482.

The Teaching of Elementary Mathematics. David Eugene Smith. New York and London, The Macmillan Company. 1900. Pp. xv + 312.

The Criminal, his Personnel and Environment, a scientific study. August Drähms, with an Introduction by Cesare Lombroso. New York and London, The Macmillan Company. 1900. Pp. xiv+40.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

At the 514th meeting of the Society, held at the Cosmos Club on March 3d, Professor C. Abbe read an obituary notice of Professor H. A. Hazen. Dr. L. A. Bauer, then gave a detailed statement of the methods to be pursued in carrying out the magnetic survey of the United States by the Division of Terrestial Magnetism of the U. S. Coast and Geodetic Survey.

As an indication of the scope and character of the data to be derived from the detailed magnetic survey of the United States, a brief statement was given regarding the results obtained from the detailed magnetic surveys of Maryland and of North Carolina. Furthermore there were exhibited various charts giving a graphical analysis of the earth's magnetic field for various portions of the United States.

With the aid of these charts, it was shown very clearly how inadequate it is for the formation of theories of the earth's magnetism to have simply declination data alone.

Following Dr. Bauer's paper, Dr. Alexander Macfarlane of Lehigh University, discussed the 'Square Root of minus one.' He reviewed the explanations published by Payfair, Buée, Argaud, Français, Gauss, Cauchy, Boole, Hamilton, Cayley and other mathematicians and concluded that $\sqrt{-1}$ does not indicate direction nor rotation of the quantity to which it is attached, nor a turning of the plane of representation, nor a special unit; that + and − are not signs of addition and subtraction but are signs of affection, and so is $\sqrt{-1}$. He gave analytical expressions for these signs, which

show their connection with π and applied them to explain the rule of signs, the roots of + and —, the logarithm of quantities, the fundamental rules of quaternions and vector-analysis, the analogy of the circle to the hyperbola, and imaginary intersections.

E. D. PRESTON,
Secretary.

THE TEXAS ACADEMY OF SCIENCE.

THE regular monthly meeting of the Texas Academy of Science was held in the Chemical lecture room of the University of Texas on Friday evening, February 16th, President Simonds in the chair.

Dr. H. Y. Benedict, Instructor in Mathematics and Astronomy in the University, spoke on 'Astronomy in the XIX. Century' which took the form of a summary of achievements in that branch of science during the past hundred years. First he considered the additions to instruments, the invention of which had materially assisted in the refinement and increase of our knowledge, special mention being made of the spectroscope, camera, photometer, etc.

Additions to the solar system constituted the next topic. These were both numerous and important, including one planet—Neptune—its satellite, the two satellites of Mars, the fifth of Jupiter, Hyperion and the ninth of Saturn, and the two of Uranus.

The cometary and periodic movements of meteorites were mentioned as were also the measurements of the parallaxes of the fixed stars.

The last topic, the 'Nebular Hypothesis and the Theory of Tidal Evolution,' aroused considerable enthusiasm. Among those who took part in the discussion were Professors Halsted, Harper, Ellis and Mezes. Throughout the paper it was made plain that in the astronomical work of the century Americans had played a leading part.

Dr. L. E. Dickson, Associate Professor of Mathematics, presented a paper entitled 'An Elementary Account of the Greater Problems solved by the Modern Group Theory.' Among the examples chosen to illustrate the definition of a group, the most elementary was that of the three distinct rotations of a plane triangle into itself, viz, the right-hand and the left-hand rotations through 120° and the zero-rotation called the identity. Denoting them by R, L, I, respectively, it is seen by inspection that

$$R^2 = L, \quad L^2 = R, \quad RL = LR = R^3 = L^3 = I,$$

so that the result of applying any one of the three and afterwards any one of the three is equivalent to applying some single one of the three. The corresponding permutations of the three vertices give rise to a 'group of substitutions.'

The connection between rational, integral functions and groups of substitutions was illustrated by several examples. The solution of the quadratic and cubic equations was made to depend upon the determination of very simple non-symmetric functions of their roots. After indicating the impossibility of solving by radicals the general equation of degree $n > 4$, the question of the solution of special equations was declared to be a problem capable of most direct answer by employing the group of the equation, as developed by Galois. A problem in mathematics usually depends upon the solution of an algebraic equation or upon the integration of a differential equation. By considering the group of the equation, finite in the former case and continuous in the latter, we are able to decide whether or not the equation can be solved by radicals or integrated by quadratures. More generally it tells what series of simple problems may be taken in place of the original problem. The group of a problem not capable of such a reduction to a chain of simpler problems is called simple. To borrow a chemical term, these simple groups are the 'elements,' to which any problem in its final analysis is to be reduced. The present state of our knowledge of these elements was discussed both for finite groups and for continuous groups.

Professor Thos. U. Taylor, M.C.E., read an abstract of his report to the U. S. Geological Survey on 'The Silting up of Lake McDonald, Austin, Texas.' This is the body of water retarded by the erection of the great dam across the Colorado River. A comparison of the cross-sections of the lake at sixteen different stations, averaging $1\frac{1}{4}$ miles apart, for 1893

and 1900, shows that the lake had silted up 48 per cent. of its original storage capacity; that when reduced to a square mile base there was in 1893 a storage capacity of 81 feet in depth, but in 1900 only 42 feet. This result, reached in the space of $6\frac{2}{3}$ years, gives an average of 5.8 feet of silt per year on the mile base. According to the laws of silting the deposit was for the first year 7.5 feet, for the second year 6.9 feet, for the third year 6.2 feet, etc. The silt in the upper two miles of the lake is mostly sand, while that of the lower two-thirds is composed of a fine, impalpable, absolutely gritless deposit. The Colorado River flows through a hilly country for hundreds of miles, and is not a heavy silt-bearing stream except on the Red Fork.

F. W. S.

University of Texas.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of March 5, 1900, forty-two persons present, the following subjects were presented:

'An Annotated Catalogue of the Muricidae,' by Mr. F. C. Baker, was presented by title.

A paper by Professor A. S. Hitchcock, entitled 'Studies on Subterranean Organs.' II. 'Some Dicotyledonous Herbaceous Plants of Manhattan, Kansas,' was presented in abstract and illustrated by specimens.

Mr. J. S. Thurman addressed the Academy on 'Liquid Air,' tracing the history of the liquefaction of gases and in particular the success reached in liquefying air since this result was first achieved in 1877 by Pictet and Cailletet. The possibilities of the utilization of liquid air as a motive power and an explosive, and its employment in medicine and as a disinfectant, were passed in analytic review by the speaker, whose conclusions were that there seemed no present probability of its useful application either as a disinfectant or a motive power. In medicine and for certain purposes requiring the use of explosives it was stated to be not impossible that it would ultimately find useful application, although its prospects as an explosive did not seem very promising.

Four persons were elected active members of the Academy.

William Trelease,
Recording Secretary.

ANTI-PLAGUE INOCULATION.

The Indian Plague Commission have made public through the India office part of their report, including the following paragraphs in regard to anti-plague inoculation:

With regard to the feasibility of adopting a general policy of inoculation, our conclusion may be set forth as follows:

(1) Experience gained hitherto has shown that it is very seldom possible to get a large proportion of the inhabitants of an uninfected place inoculated.

(2) It has been possible, where the inducement of exemption from segregation and eviction has been offered, to get a large proportion of the inhabitants of an infected place inoculated quickly.

(3) It has been possible in one place—Mysore City—even where no inducement that touched the great mass of the people could be offered, to get a considerable proportion of the inhabitants of an infected place inoculated quickly.

(4) It has been possible also to induce a large proportion of particular communities, such as the Khojas of Bombay and Karachi, to be inoculated under the influence of their leaders.

Our recommendations are governed by those conclusions, as well as by the conclusions we have already drawn with regard to the protection conferred by inoculation. They are further governed by the consideration that it is necessary, as far as may be possible, to dispel the particular objections on account of which the people have hitherto refrained from inoculation. Moreover, our recommendations are based on the consideration that it is advisable to make the operation as effective as possible, as little inconvenient as possible to the person inoculated, and as easily carried out as possible by the inoculator.

I. We have already insisted on the necessity for the accurate standardization of the vaccine, as being essential to the attainment of the best results, both as to the protection conferred and as to the duration of that protection. We have pointed out, also, that the introduction of an accurate system of standardization may possibly obviate the necessity of employing two successive inoculations.

II. With a view to dispelling the natural