paper of Professor J. Willard Gibbs, on 'Graphical Methods in Thermodynamics,' in the Transactions of the Connecticut Academy of Sciences, 1873, the 'entrophy-temperature diagram' has attracted little attention until within a comparatively few years. Brought out by that writer twenty-five years ago, it was left unnoticed for a long time, and it was only when, recently, the eminent and able mathematical physicist and engineer, Mr. J. MacFarlane Grey, employed it in his papers, read before the British Institution of Naval Architects, and later, Professor Cotterill took it up, and the late Mr. Willans gave it practical application in the exposition of the experimental work on his engines which gave him fame, that it has been thought worth while, on the part of engineers, to make use of what proves to be a very beautiful method of exhibiting heat-exchanges and transformations in heat-engine cycles, and especially with the steam-engine.

The recent publication of Professor Ewing on the steam-engine, in which this system is employed to some extent, has called attention to the subject once more, and the indications would seem to be that the entropy-temperature diagram will now find frequent use in the hands of the engineer in the exposition of thermodynamic problems.

The particular form given this diagram, in order to make it available for general use, in this publication by Professor Reeve, is that adopted by Professor Boulvin, of Ghent University, modified by the present author to meet the demands of the profession in a more complete and satisfactory manner. It exhibits the four quadrants, devoted in the present case to entropy-volume changes of steam, to volume-pressure, to temperature-pressure and to entropy-temperature variations, taking the series clockwise, and exhibiting the various curves drawn to a moderately large scale. There are also printed upon the sheet the proper tables and blanks for use in tabulating data of steam-engine trials. Accompanying is a text, descriptive of the diagram and its uses, indicating the character of its lines and the methods of analysis appropriate to the purposes of the engineer.

The text is concise and clear and the plate well made. It would be an improvement were the latter given a light and strong cloth backing, and were a pocket supplied in the cover of its text, in which to preserve it. The cost would be slightly increased, but the sheet would be thus rendered comparatively safe. With care in mounting, and inspection afterward, the diagram could probably be thus guarded without measurable distortion.

The diagram should find many users and prove of real assistance to many investigators and illustrators of thermodyamic problems.

R. H. THURSTON.

CORNELL UNIVERSITY.

## SOCIETIES AND ACADEMIES.

### ANTHROPOLOGICAL SOCIETY, WASHINGTON.

THE 274th regular meeting of the Anthropological Society was held Tuesday, March 1, 1897.

Dr. J. Walter Fewkes read a paper on 'The Altar of the Great Snake of Walpi,' which he described in detail, and stated it to be different from those of the Snake Dance proper.

A number of illustrations, colored charts and drawings were used to show the structure and construction of the altar.

In his paper on 'Snake Worship among the Navaho,' Dr. Matthews stated that the Navahoes have ophiolatrous rites; but they do not handle or introduce live snakes after the manner of the Moki. While their rites do not seem to be derived directly from those of the Moki both have much in common and are probably borrowed from a common source; still they differ in many important respects. The ceremonial circuits are different. A Navaho will not kill a snake; if he finds one coiled in his path he will lift it gently with a stick and throw it to one side. They think the serpent possessed of extraordinary wisdom; that it understands human language and may make evil use of human knowledge; hence their most sacred rites may be performed and their myths may be told only in winter, when the snakes are hibernating. A picture was shown which was a copy of a Navaho dry-painting or sand-altar. It might be considered a Navaho snake-altar. It represented the home of the Navaho snake-god; a minute description of it was given.

Dr. Matthews recounted various reasons why the snake was held sacred by men in all ages and in all parts of the world where it existed. Among the Navahoes he thought the principal reason was that the snake was associated with the lightning. Lightning is regarded as a celestial serpent; hence serpent worship is thought to bring rain. A Navaho myth was related which illustrated the connection between the serpent and lightning. A connection between the feathered rainbow of the Navahoes and the feathered serpent of the Mayas was suggested.

Discussed by Major J. W. Powell, Dr. W J McGee and Mrs. M. C. Stevenson.

J. H. MCCORMICK,
*Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 75th meeting, held in Washington on Wednesday, March 9, 1898, the following papers were read:

T. W. Stanton, 'The Mesozoic Section of Sierra Blanca, Texas.'

The strata described are exposed in the mountains and hills within a few miles of Sierra Blanca station, at the junction of the Southern Pacific and Texas Pacific Railroads, ninety miles east of El Paso. The special object of the paper was to describe the occurrence of marine Jurassic strata, whose discovery was recently announced by Professor F. W. Cragin, in the *Journal of Geology*, and to present the paleontological evidence of their age. The beds are limestones, shales and calcareous conglomerates overlying important beds of gypsum which should probably also be referred to the Jurassic. Fossiliferous outcrops one and a-half miles east of Malone station and on the west side of Malone Mountain have yielded about forty species of marine invertebrates of Jurassic types and all distinct from the Lower Cretaceous species of the same region. The fauna is somewhat related to that of the Jurassic at Catorce, San Luis Potosi, Mexico.

F. H. Knowlton, 'The Belly River Horizon on the Upper Missouri.'

The author described briefly the characteristics and extent of the Canadian Belly River beds and the probable preserver of similar beds along the upper Missouri, in the vicinity of Coal Banks, where Messrs. White and Ward discovered a fossil plant locality in 1883. At this point there is a massive light-colored sandstone one hundred feet or more in thickness, associated with coal seams, that is, immediately above beds that contain an invertebrate fauna which seems intermediate between the Colorado and Montana formations. The fossil plant locality is just above this massive sandstone. Farther down the Missouri, near the mouth of Arrow River, the dark Fort Pierre shales, with a characteristic fauna, are seen to clearly overlie this sandstone, and still above that comes the section near the mouth of Judith River, which includes the Fox Hills, or Upper Montana, and the Judith River beds, which are true Laramie.

The flora consists of seven species, two of which are true Laramie species and have not before been found outside of this formation. The remaining forms are regarded as new to science. Of these, three are closely allied to Dakota group species, one to a Laramie species and the other is too poorly preserved to admit of satisfactory comparison.

W. F. MORSELL.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St Louis of February 21, 1898, thirteen persons present, Dr. R. J. Terry exhibited a specimen of a cervical rib from a human subject and discussed the occurrence of structural anomalies of this character. Fifteen persons were elected to active membership.

At the meeting of March 7, 1898, twenty-eight persons present, Professor C. M. Woodward presented a paper embodying an analytical discussion of the efficiency of gearing under friction. The substance of his paper had been given to his class in 1896, and was believed to be new. Few works on applied mechanics, the speaker stated, give any discussion of the matter. Only spur wheels with epicycloidal and involute teeth were considered. The method of investigation was briefly this:

Assuming a coefficient of friction ($f$) and a constant moment in the driving wheel, the magnitude of the friction overcome, multiplied by the velocity of sliding and again by $dt$, gave an

expression for the differential of the energy lost in an element of time. The general form for the energy lost is:

$$U = M \sin \psi \, (a_1 + a_2) \int \frac{r dt}{l}$$

in which $\psi$ is the 'angle of repose,' $M$ is the driving moment, $a_1$ and $a_2$ are the angular velocities of the driving and driven wheels respectively, $r$ is the distance from the point of contact to the pitch point, and $l$ is the perpendicular upon the resultant line of action from the axis of the driver. This integration was effected for the 'approach,' then for the 'recess,' and their sum was divided by the whole energy exerted by the driver. This gave the *ratio* of energy lost to energy exerted.

For epicycloidal teeth the exact formula was very complex, but a close approximation was obtained in the following form:

$$\text{Ratio} = r_0 \frac{r_1 + r_2}{r_1 r_2} (0.546 f + 2.72 \frac{r_0}{r_1} f^2).$$

For involute teeth an approximate formula was also obtained in this form:

$$\text{Ratio} = \frac{r_1 + r_2}{2 r_2} (f \cot \theta - \frac{2}{3} f^2 \cot^2 \theta)$$

in which $\theta$ is the constant angle between the normal to the teeth and the line of centers. These ratios subtracted from unity give the efficiency.

For the sake of comparison, a table was produced giving the efficiency for different values of the coefficient of friction $f$, and for equal wheels and for the same number of teeth, 12, on each wheel.

Efficiency of Spur Wheels. Equal wheels with 12 teeth each.

| Kind. | $f=0.03$ | $f=0.10$ | $f=0.15$ | $f=0.20$ | $f=0.25$ |
|---|---|---|---|---|---|
| Epicycloidal. | 0.9915 | 0.9693 | 0.9514 | 0.9318 | 0.9103 |
| Involute. | 0.9923 | 0.9746 | 0.9622 | 0.9501 | 0.9381 |

Dr. Amand Ravold demonstrated the method, recently introduced by His, of differentiating the typhoid bacillus from Bacillus coli-communis, by the use of semi-solid acidulated media, in which, at blood temperature, the round colonies of the typhoid bacillus assume a peculiar fimbriated form of growth, because of the motility of the bacteria in the slightly yielding medium, which, in most cases, readily distinguishes them from the more whetstone-shaped colonies of the colon bacillus, which does not produce the peculiar fimbriation in plate cultures. In tube cultures in the same general medium, but prepared with a slighter acidity and somewhat less solidity, a uniform clouding of the entire tube, due to the swarming of the bacteria, was shown to be characteristic of the typhoid bacillus, while the colon bacillus was definitely confined to the immediate vicinity of the thrust. The media in both cases are made up without peptone. The formulæ are:

| For Plate Cultures. | For Tube Cultures. |
|---|---|
| Agar.....10 grams. | Agar.....5 grams. |
| Gelatine .....25 " | Gelatine. .....80 " |
| Beef extract...5 " | Beef extract... 5 " |
| Glucose.....10 " | Glucose .....10 " |
| Salt..... 5 " | Salt ..... 5 " |
| Normal acid...20 cc. | Normal acid...15 cc. |
| The whole increased to 1000 cc. | The whole increased to 1000 cc. |

The growth of the two species in question, on potato and in milk cultures with litmus, was also demonstrated.

Eight persons were elected to active membership.

WILLIAM TRELEASE,
*Recording Secretary.*

TORREY BOTANICAL CLUB, FEBRUARY 23, 1898.

THIS meeting was held in the large lecture hall of the College of Pharmacy, and about 150 persons were present. Vice-President Rusby presided. The minutes were read and approved. Arrangements were announced for summer courses in botany, provided by the committee of instruction of the Club. Course 1, is to commence March 4th, at the College of Pharmacy under Mr. W. A. Bastedo, with weekly lectures and excursions on Saturdays. Pursuant to motion of Dr. Britton, the chairman made this evening the announcement of the Field Committee for the year 1898, to consist of three members, with power to add to their number. The Committee was announced to consist of Mr. W. M. Clute, chairman; Professor F. E. Lloyd and Mr. W. A. Bastedo. The evening was devoted to an illustrated lecture by Mr. Cornelius Van Brunt on the wild flowers of the Canadian Rockies, with lantern slides exquisitely colored from nature by Mrs. Van Brunt. Numerous

views of the scenery of their surroundings were shown, especially of the Selkirk Mountains and about Banff. Here, instead of *Rudbeckia* and *Leucanthemum*, *Gaillardia aristata* covers the fields with multitudes of purple and yellow flowers. Vetches are numerous, blue clover (lucerne) takes the place of red; turf for the lawns is composed of Buffalo clover only (*Trifolium reflexum*). Beautiful examples of *Hedysarum*, *Lathyrus* and *Oxytropis* occur among the Leguminosæ; *Linnæa borealis*, *Potentilla fruticosa* and several species of *Allium* were abundant, also *Parnassia palustris* and *P. fimbriata*. Near the hotel at Banff great numbers of Shepherdia bushes are hung with their red berries. The red berry-like fruit of the Strawberry-Blite, *Chenopodium capitatum*, was seen in great abundance in parts of the Canadian National Park, as was *Galium boreale*, *Anaphalis margaritacea* and several species of *Gentiana* and of *Pedicularis*. The Asters were represented by *A. Fremonti*; instead of the dandelion, *Troximon* with similar blossom had become the most common flower; myriads of hare-bells, apparently *Campanula rotundifolia*, dotted the roadsides, and the horse if left to himself would hunt them out as the choicest eating. One field was a beautiful mass of squirrel-grass, *Hordeum jubatum*; larkspurs grew all along the road; blue flax (*Linum Perenne*) and *Rosa acicularis Bourgeana* were still in blossom. About the numerous hot springs and ponds formed from them grew plants of warmer latitudes, here blooming early, as *Gentiana detonsa* in July. *Lobelia Kalmii* was blooming in the hot water. Many parts of this park have lost their beauty from the continuous forest fires. The Canadian Pacific Railroad employs watchmen whose sole duty is to guard against these fires. Digging shows that such fires have ravaged this region since times before history. The blackened ground is slowly covered by fireweed (*Epilobium angustifolium*) and, after the charred trees have fallen, by vigorous young growth of balsam-spruce and pine. The abundant painted cup disputes with the fireweed the position of most showy flower of the region. An interesting visit to Lake Louise and neighboring glaciers was described, also to Mirror L., with altitude of 5,480 feet. Great numbers of crossbills were met near the glacier, feeding upon pine cones; three columbines, *Aquilegia*, were close to the snows, with *Ledum latifolium*, *Pentstemon Menziesii*, *Valeriana Sitkensis* and *Arnica cordifolia*. *Habernia hyperborea* was everywhere through the woods. The moss-campion, *Silene acaulis*, covered dry rocks with long tap-roots going down three feet or more to water. Strangely enough, the night-flowering catchfly, *Silene noctiflora*, was here in force. *Bryanthus* and *Cassiopea* were in fine flower. Lyall's Larch grew higher up the mountain than any evergreen, and its bright green was already turning now in August to its autumn yellow.

EDWARD S. BURGESS,
*Secretary.*

## THE NEW YORK ACADEMY OF SCIENCES—SECTION OF BIOLOGY, FEBRUARY 14, 1898.

THE first paper was on 'The Eparterial Bronchial System of the Mammalia,' by Professor Geo. S. Huntington, a full abstract of which will appear in an early number of SCIENCE.

Professor F. S. Lee followed with a report of his researches on 'The Function of the Ear and the Lateral Line in Fishes.' Previous work by the author has shown in detail that the ear of fishes is a sense-organ of equilibrium, the semicircular canals mediating the perception of rotary movements, the otolithic portions that of the position of the body in space. The paper reported the results of experiments proving that the otolithic organs mediate also the perception of progressive movements. Thus the hypotheses of Mach and Breuer in this regard are experimentally confirmed. All attempts of the author, as well as those of Kreidl and others, have failed to demonstrate in fishes the existence of any power of hearing in the customary sense of the word. It must be concluded that this sense is wanting and that the ear in fishes is purely equilibrative in function.

Cutting of all the nerves supplying the organs of the lateral line, or destruction of the organs, does not appear to have any effect on the fish; but this should be re-examined. Destruction of the organs, however, combined with the removal of the large pectoral and ventral fins in *Batrachus tau* causes evident lack of apprecia-

tion of equilibrium both during swimming and at rest. More important is the fact that central stimulation of the lateral nerve causes coordinated compensating movements of the fins, exactly similar to those caused by similar stimulation of the acoustic nerve. In both cases a reflex arc between sense-organs and locomotor organs exists. The inference is that the organs of the lateral line are sense-organs of equilibrium analogous to the ear. These results testify indirectly to the correctness of the theory that the ear is a derivative of the lateral line. The equilibrium function is crude in the latter, more perfected and differentiated in the former. The sense of hearing in vertebrates arose along with the change from a water to a land existence, and the appearance of a *papilla acustica basilaris*. In vertebrates above the fishes, the ear appreciates all kinds of visible motion that the physicist recognizes, rotary, progressive or translatory and vibratory.

Gary N. Calkins,
*Secretary of Section.*

## SCIENTIFIC JOURNALS.

*The American Naturalist* for February opens with an article by E. C. Case, reviewing the significance of certain changes in the temporal region of the primitive reptilia. This is followed by a paper by the late James Ellis Humphrey on Manasseh Cutler, one of the pioneers of American science, born in 1741. Professor J. H. Comstock and Mr. J. G. Needham continue their study of the wings of insects, taking up the venation. Other articles follow by Dr. F. C. Kenyon on the daily and seasonal activity of a hive of bees, by Dr. Erwin F. Smith on the first annual meeting of the Society for Plant Morphology and Physiology, and by Dr. Charles E. Bessey on some characteristics of the Foothill vegetation of western Nebraska.

The contents of the April *Monist* are predominantly philosophical. The number opens with an article by Professor John Dewey on 'Evolution and Ethics,' which seeks to correct the view of the late Professor Huxley that Nature is essentially unmoral. Dr. Woods Hutchinson, of the University of Buffalo, writes on *Lebenslust*, a scientific homily upon the nobility and righteous pleasure of being alive; E. E. Constance Jones discusses 'An Aspect of Attention;' Professor C. Lombroso seeks to substantiate his theory of the degeneracy of genius by considering certain 'Regressive Phenomena in Evolution,' while Professor Ferdinand Hüppe, of Prague, discusses in a long contribution, and in the light of a special philosophical theory, the 'Causes of Infectious Diseases,' attacking the prevailing views of Virchow, Pasteur and Koch. Finally, in a disquisition entitled 'The Unmateriality of Soul and God,' Dr. Paul Carus attempts to banish the metaphysical materialistic notion of substance from the domains of psychology and theology.

*The Atlantic Monthly* for April contains an article by Professor George H. Darwin which analyzes the relations of the earth to the moon and the solar system, the tidal phenomena produced by the moon which react upon it in turn, and details the prospective future history of the two bodies down to the times when they will revolve in unison, and our days and months will be of the same duration. Mr. John Muir continues his articles upon Government Parks with a description of the Yellowstone. Dr. McGee contributes a vivid description, in part based on personal experience of the five stages of thirst in the desert.

## NEW BOOKS.

*Évolution individuelle et hérédité.* Felix Le Dantec. Paris, Alcan. 1898. Pp. 308.

*Practical Electricity and Magnetism.* John Henderson. London, New York and Bombay, Longmans, Green & Co. 1898. Pp. xv+388.

*Birds of Village and Field.* Florence A. Merriam. Boston and New York, Houghton, Mifflin & Co. 1898. Pp. vi+406. $2.00.

*A Laboratory Manual in Practical Botany.* Charles H. Clark. New York, The American Book Company. Pp. 271. 96 cents.

*The Story of Life in the Seas.* Sidney T. Hickson. New York, D. Appleton & Co. 1898. Pp. 173. 40 cents.