THE FOSSIL FIELD'S EXPEDITION TO WYOMING.

IN June last, the Union Pacific Railroad Company issued a large number of invitations to colleges, universities and museums doing work in geology, to participate in an exploring and collecting tour through the fossil fields of Wyoming, long famous for their remains of various extinct vertebrates. Free transportation was furnished by the railroads from Chicago and return, as well as from other northern and southern railroad centers, to Laramie, Wyoming. At Omaha, Mr. A. Darlow, for the Union Pacific Railroad Company, bade all welcome, looked after the comfort of the guests, and accompanied the expedition to Laramie. The party began to arrive in the latter place July 19th, that day being spent in the election of officers, and in the final preparations for camp life. In the evening, the élite of the university City of Wyoming gathered at the University, where President Smiley extended a cordial welcome to all.

Professor Wilbur C. Knight was elected president and director of the expedition. Wagons, tents, bedding, provisions, and other necessary articles for camping were furnished the members, and, as it afterwards proved, at less than the actual cost. The 'outfit' moved out of Laramie, July 21st, and consisted of 19 two-horse wagons and a few saddle horses, thus providing transportation for 85 men. The party was composed of 66 geologists, paleontologists, botanists, photographers and reporters, with 19 teamsters. Seven of the latter also officiated as 'camp cooks,' each of them purveying to a mess including generally 10 persons. The newspaper men were the first to drop out, and after the North Fork of the Platte River was reached, a little over twenty days out, the expedition was reduced to 14 men. These completed the tour of forty days, as originally planned by Professor Knight, and had a most profitable and enjoyable trip. During these 'forty days in the Wilderness,' we traveled upwards of 300 miles over the treeless, sagebrush plains of eastern Wyoming, and made 18 camps, sometimes besides an alkaline lake, but oftener by a small spring or stream. In this arid region it rained frequently during the first four weeks, and though the rains were generally light they greatly surprised us. On July 23d, we had a snow-balling and alpine flowers in the Medicine Bow Mountains, at an altitude of about 9,000 feet; while on August 11th and again on the 24th, ice formed.

Thirty-two institutions of learning and research, from California to Massachusetts and from Minnesota to Texas, were represented in this expedition which offered so great an opportunity for geological observavation and study. Here could be seen plains 6,000 feet or more above sea level, some almost smooth and others more or less dissected, or several one above another all with the original bedding disturbed and tilted at an angle of from 10 to 30 degrees. Above these, in the distance, lay the Tertiary plateau, which to the eye is an absolute plain abutting against the granite mountains. Here and there over these plains are lakes, usually more or less alkaline, some without outlets produced by the solvent action of water percolating through the strata. At this great altitude could also be seen sluggish meandering streams with closely adjoining horse-shoe curves, the equals of any near the sea level. Towards the mountains the strata gradually stand more and more vertical in series, like so many stone walls, with the dike-cut granite not far away. On the plains, wind action could also be studied, sometimes in the linear arrangement of the sage brush, but frequently in the general polish and occasional faceting of surface pebbles and boulders. In general, the opportunity for studying geology could hardly be surpassed,

since much of Wyoming is one continuous exposure. After seeing this country, it becomes easy to understand how it was possible for a party of the Hayden Survey to prepare, in one field season, a reconnaissance map covering as many as 20,000 square miles.

The most interesting region of the trip, from a picturesque and geological standpoint, was that about the Grand Canyon of the North Platte. We first saw this from the high sage-covered Tertiary crest at 6,800 feet. Back of us were the rounded Indian Grove Mountains of granite, while long and dark Ferris Mountain stood on our left across the river. Directly in front was spread before us, like a painted stereoptican projection, the Grand Canyon country of the North Platte. The hills here have their escarpment directed towards the west, and are superposed like tiles on a roof. Beginning on our left were granite hills followed by those of Carboniferous, Triassic and Jurassic age, in places partially repeated, and all surmounted by the thick Tertiary lake beds. The colors of this panorama were pronounced and pleasing, especially when freshened by a rain, as when we first saw them. The brick-red color of the Triassic contrasted strikingly with the light green of the Jurassic and the browns of the Tertiary passing upwards into ash-colored beds. Hidden in this picture across the strike was the Grand Canyon of the Platte, eight miles long and in places nearly 1,000 feet deep. Over to the right may be seen the silver thread of the river issuing and flowing through the open country, but it is soon lost to view in the Little Canyon, which is 400 feet deep and about half a mile in length. Both gorges have perpendicular right-angled walls, and are very narrow, so narrow in places that a stone can be tossed across. Only one party is known to have gone through the Grand Canyon of the North Platte. This consisted of Freemont with Mr. Preuss and 'five of my best men,' Canadian voyageurs, who started in a canvas boat, August 24, 1842. The passage was extremely dangerous, and finally, at the foot of a fall, the boat was whirled over and men and baggage were thrown into the raging stream. Luckily no one was drowned, but most of the baggage was lost. In the Little Canyon, which is through a faulted ridge, there is a large hot spring that contains light-green algæ. This water is now piped half a mile to Alcova, where a pioneer has a primitive 'Hot Springs Resort' fifty miles from a railroad.

Another very interesting region was Bates' Hole, a narrow hole-like valley in Tertiary strata with a maximum depth of 1,500 feet. It is drained by Bates' Creek, a tributary of the North Platte, near Alcova. The lower level is in a series of delicately tinted yellow, red, green, and whitish Eocene shales and soft sandstones. Above, along the margin of the Hole, are the Titanotherium beds of the Lower Miocene, which are picturesquely castellated, series above series, in places 400 feet or more high. This constitutes another style of 'Bad Land' scenery. Here Professor Knight made use of an unusual method for ascertaining the time required for the erosion of Bates' Hole. The marginal slopes are often very steep, and upon them are growing isolated slowly dying pines perched by their roots from one to three feet above the present surface. Since the annual growth rings of the trees will indicate their age, a time measure is at hand for the amount of strata removed from beneath the tree. This, when taken in connection with the size of the Hole, will give some idea as to its age. A provisional estimate places it at 1,584,000 years since the close of Miocene time. (See Science, for October 27, 1899.)

Several tons of good fossils, mainly invertebrates, were collected during this trip.

Many of the members also expected to secure a Dinosaur each, but the magnitude of the work soon changed enthusiasm into regret. In the very beginning, alarming setbacks are encountered when climbing the hills in any direction for a 'bone lead.' Having the good fortune to discover one, the real work then begins in the digging, only to find that every bone is cracked into innumerable pieces. These must be bandaged and set in plaster, and when all is hard the bones can be turned to undergo more bandaging. This means that one must have patience, be expert with pick and shovel, with gunny sacking and plaster, and with saw and hammer. However, with all these difficulties to overcome, no less than six car loads of bones were shipped this summer from Medicine Bow, a little village on the Union Pacific Railroad in Wyoming, by specially organized parties from the Universities of Wyoming and Kansas, and the Field, Carnegie and American Museums of Natural History.

In no one place are complete Dinosaur skeletons found. Sometimes a 'quarry' will yield a lot of vertebræ, or a number of either hind or fore limbs, or there is a general mixture of parts of animals of different genera. To make an adequate collection of Jurassic Dinosaurs, therefore, requires several successful field seasons. The cost is still further enhanced since in the laboratory the bones must be cleaned, hardened and restored before they are ready for study and exhibition. On account of these conditions and the further one that Dinosaur skeletons are very large, the work is extremely expensive. We can, therefore, believe that the best skeleton of Brontosaurus in Professor Marsh's collection, an imperfect one, cost him $10,000.

The wonderful newspaper stories of last spring about the finding of a Dinosaur indicating a length of 130 feet is the prize paleontological story of the season. The "ghoul of science, Mr. Reed" outdoes Stockton when he writes "that the animal now being brought to light weighed in life about sixty tons, that he had a neck thirty feet in length, and a tail perhaps sixty feet in length. His ribs are about nine feet in length, and the cavity of his body with the lungs and entrails out, would have made a hall thirty-four feet in length, sixteen feet in width, and arched over probably twelve feet in height. A round steak taken from the ham of the animal would have been at least twelve feet in diameter. * * * A set of fours in cavalry could easily have ridden abreast between his front and hind legs, provided he had not objected. Every time he put his foot down it covered more than a square yard of ground and must have fairly shaken the earth. * * * When we get it here we shall probably place it temporarily in the campus * * * and we shall work as rapidly as possible in restoring our great prize to a normal condition here at Larmie." This wonderful story is based on two little holes in the Freeze Out Hills, which required about a day to dig. When all is exhumed, if there is anything to exhume, it will be found that 'our great prize' is after all but a normal Dinosaur. The excitement produced by the story, however, has another side, and a good one, since it led our newest Museum to take up the making of a collection of extinct monsters.

One of the great needs for geological work in Wyoming is good maps. Those available this summer were very poor; therefore nothing was attempted in the way of preparing geological maps.

In addition to the collections made and the individual 'experience' the expedition secured a number of new species of invertebrates. They located two new leaf horizons in the Fox Hills formation, a limestone with an abundance of fossils in the Red Beds supposed to be of Triassic age, and an-

other abounding in fresh-water shells together with turtle and crocodile remains in the Jurassic Dinosaur beds. On the basis of the fossils collected this summer, the Carboniferous of Shirley Basin and the Grand Canyon of the North Platte are to be correlated with the Madison limestone of the Yellowstone Park. The Carboniferous at 'Specimen Hill,' near the ranch of John Burnett in the Little Medicine settlement, is, however, of Upper Carboniferous age.

Game at times was plentiful. On the plains, we saw daily from a few to as many as fifty antelope, but we rarely got nearer to them than a half mile. Sage hens were also abundant. In the mountains, two species of grouse were seen. Beaver dams we saw only in the region of Larmie Peak. Coyotes were noticed daily and nightly we never failed to hear their broken-voiced barking. Bears and mountain sheep were not seen, but occasionally we came across their tracks. Jack-rabbits were not common, eagles very scarce, and but four rattlesnakes were killed.

In conclusion, it is believed that the sentiment of the members of the Fossil Field's Expedition is voiced when it is stated that we were particularly fortunate in having Professor Knight as chief geologist, leader, and quartermaster. He did his work well, and we are the gainers in making his acquaintance.

"The Dinosaur, King of the mountains,
The largest of all vertebrates;
When he drank he exhausted the fountains,
And no one can tell what he ate.
He went about in the Jurassic,
And he'll never come back any more;
His bones lie here in Wyoming.
Three cheers for the old Dinosaur."

Vincent, Coe College.

Charles Schuchert.

U. S. National Museum,
October 26, 1899.

SCIENTIFIC BOOKS.

THE 'THETA-PHI DIAGRAM.'

The Entropy-Temperature Analysis of Steam-Engine Efficiencies. By Sidney A. Reeve. New York. 1897. 8vo. Pp. 20, with folded diagram.

The Theta-Phi Diagram practically applied to Steam, Oil, Gas and Air-Engines. By Henry A. Golding. London, Manchester and New York. 1898. 12mo. Pp. 127.

The Entropy-Diagram and its Applications. By J. Boulvin. Translated by Bryan Donkin. London and New York. 1898. Pp. 70.

The 'temperature-entropy diagram,' the 'theta-phi diagram,' as some recent writers, following Macfarlane Gray, are coming to denominate it, was suggested, somewhat indefinitely and without illustration of its applications, by Belpaire, in 1872; by J. Willard Gibbs, in a very definite form and with clear statement of the uses to which such a diagram may be applied, in 1873–1878, and by later writers in increasing numbers and with as steadily increasing extent and usefulness of application, particularly in the treatment of the theory of the ideal heat-engines and in their comparison with the real engines of daily life. About 1889 Macfarlane Gray presented papers to the British Institutions of Naval Architects, of Civil and of Mechanical Engineers, in which he employed the diagram in 'the rationalization of Regnault's experiments on steam' and other work so skilfully and effectively that the attention of his profession was then called to the then novel device, with the result of its permanent introduction into the current methods of thermodynamics, pure and applied. It was subsequently used very extensively by Willans in the discussion of the efficiencies of his engines, as exhibited by a series of famous trials which were brought to an abrupt termination by the early death of that talented engineer; although supplemented with great ability by his coadjutor, Captain Sankey. Boulvin, Ewing, Donkin and Cerry have since introduced this method of discussion of efficiencies and wastes of the heat-engines into treatises on those machines and their theory, and it may be now safely assumed that the system of Gibbs and his contemporaries in its development has become fully established