NATURAL HISTORY OF CENTRAL ASIA
VOLUME I

THE NEW CONQUEST OF CENTRAL ASIA

美國博物館
中亞調查記

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CENTRAL ASIATIC EXPEDITIONS

THE NEW CONQUEST OF CENTRAL ASIA

A MONGOL WOMAN OF URGA WITH A LAMA AND PRAYER WHEEL

From a painting by Arthur A. Jansson

CENTRAL ASIATIC EXPEDITIONS
ROY CHAPMAN ANDREWS, *Leader*

THE NEW CONQUEST OF CENTRAL ASIA

A NARRATIVE OF THE EXPLORATIONS OF THE
CENTRAL ASIATIC EXPEDITIONS
IN MONGOLIA AND CHINA, 1921–1930

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H. F. OSBORN, C. H. POPE, C. A. REEDS AND L. E. SPOCK

With 128 Plates and 12 Illustrations in the Text and Three Maps at end

NATURAL HISTORY OF CENTRAL ASIA
VOL. I
CHESTER A. REEDS, PH.D., *Editor*

THE AMERICAN MUSEUM OF NATURAL HISTORY
HENRY FAIRFIELD OSBORN, *President*
NEW YORK
1932

THE NEW CONQUEST OF CENTRAL ASIA

Published, December 29, 1932
First Edition

Made in the United States of America.

To

THOSE GENEROUS CONTRIBUTORS

Who

Through Their Interest in Science and

Exploration Made Possible the

Central Asiatic Expeditions

This Book

is

Gratefully Dedicated

PREFACE

THIS book is an introduction to the scientific publications on the explorations of the Central Asiatic Expeditions in Mongolia and China, from 1921 to 1930. It tells how the work was done and attempts to give a picture of the country itself, of the Expeditions' daily life in camp and on the trail, of the transport by camels and motor cars, and of the principal discoveries in the various branches of science represented. It has been written to give the layman a comprehensive view of the Expeditions and makes no attempt to discuss the discoveries in detail, inasmuch as that is done in the series of scientific volumes which follow.

For much technical information I have drawn freely upon the Preliminary Reports of the Expeditions' work, published in the *American Museum Novitates;* also upon Volume II, "Geology of Mongolia," by Professors Berkey and Morris, and upon Volume IV, "The Permian of Mongolia," by Professor Grabau, in this series. To the authors of all these publications I owe my best thanks.

The permanency and value of any exploration lie in its published reports. Long after the field work has been forgotten, these volumes will remain as a record of accomplishment.

The success of the work was due to no one man. The Expedition of each of the various years was a well-balanced machine in which every member was a vital part. Had any individual failed in his allotted task, the efficiency of the machine would have been impaired, if not fatally crippled. The services of brilliant scientists having been obtained, the way in which they coöperated as a unit and worked for one ideal without friction insured success. During all the years we were in the field we lived as a happy family without a single quarrel. This is an almost unique record and one of which we are justly proud. No finer, more loyal or more devoted group of men could ever be brought together. The privilege that I had of organizing the Expeditions and leading them in the field and the personal loyalty of the men to me will ever remain as my most treasured memories.

To those individuals and institutions who financed the Expeditions, we owe a debt which we could attempt to pay only by utilizing to the utmost the opportunities which they so generously afforded us. Particularly are we

indebted to *Asia* magazine, New York, and to the Field Museum of Natural History, Chicago. They have our deepest gratitude.

Without the prophetic vision and the enthusiastic interest and assistance of Professor Henry Fairfield Osborn, President of the American Museum of Natural History, the Expeditions never could have become an accomplished fact or continued to operate. The Board of Trustees of the American Museum, individually and collectively, gave us the most loyal support in every way. To Director George H. Sherwood we feel a peculiar gratitude; upon his shoulders fell much of the administrative work of the Expeditions while we were in the field; to him we turned for every conceivable detail, personal as well as official, and always received a cheerful response. Mr. Frederick H. Smyth, Bursar of the Museum, handled the financial matters in his usual efficient manner. The former American Minister to China, Mr. J. V. A. MacMurray, was my guide and confidant in carrying on the diplomatic negotiations with the various Chinese governments which year by year became increasingly difficult. He gave unstintingly of his time and thought to our affairs.

To Doctor Walter Granger, I owe a great personal debt. As Second in Command of the Expeditions, we worked together in the most complete harmony. Without his unselfish support and his profound knowledge of palæontology and field work, the Expeditions never could have achieved the degree of success which rewarded our explorations. Moreover, he has given freely of his time and thought in the preparation of this volume.

I am also indebted to Doctor Chester A. Reeds for his arduous editorial work which has greatly enhanced the value of the book.

It is impossible to mention by name the hundreds of individuals and business organizations that rendered us substantial aid. Many of them are referred to in the body of the work. Without their generous response and assistance our task would have been made much more difficult.

It is a source of the deepest regret that, after the Nationalist Party obtained control of China in 1928 and the capital was changed from Peking to Nanking, the cordial relations, which had existed under the Peking government between the Expeditions and Chinese institutions and officials, became increasingly strained. With the advent of the new government, all projects concerning foreign explorations were referred to the Society for the Preservation of Cultural Objects.

In September, 1928, this society, later known as the National Commission for the Preservation of Ancient Objects, seized our collections upon their arrival in Kalgan. A period of negotiations followed between Washington, Nanking, Peking and the Commission. After six weeks of effort our collections at Kalgan were finally released.

Following the seizure of the Expedition's collections, the Commission for the Preservation of Ancient Objects continued to oppose the work not only of our Expedition, but also of other foreign expeditions. As a result of this opposition our work was suspended in the year 1929, restricted in 1930, and brought to a full stop in 1931, despite the continued efforts of President Osborn of the American Museum of Natural History in New York, Secretary of State Stimson at Washington and representatives of our State Department in China. Notwithstanding this present opposition on the part of Chinese institutions and officials, it is to be hoped that the dawn of a more tolerant era of sympathy and coöperation with foreign scientific endeavor will not be long delayed.

Roy Chapman Andrews.

The American Museum of Natural History,
New York, N. Y.
April 29, 1932.

SCIENTIFIC AND TECHNICAL STAFF OF THE CENTRAL ASIATIC EXPEDITIONS

Andrews, Roy Chapman.—Leader and Zoölogist, 1921-1930.

Badmajapoff, T.—Mongolian Political Representative, 1922.

Beckwith, Radcliffe H.—Geologist, 1926-1927.

Berkey, Charles P.—Chief Geologist, 1922-1925.

Butler, F. B.—Assistant Topographer, 1925.

Chaney, Ralph W.—Palæobotanist, 1925.

Colgate, S. Bayard.—Chief, Motor Transport, 1922.

Eriksson, Joel.—Agent in Mongolia, 1926-1930.

Garber, A. Z.—Surgeon, 1930.

Grabau, A. W.—Research Associate, 1922-1930.

Granger, Walter.—Chief Palæontologist, Second in Command, 1921-1930.

Hill, W. P. T.—Topographer, 1928.

Horvath, G.—Motor Transport, 1928.

Johnson, Albert F.—Assistant in Palæontology, 1923.

Johnson, C. Vance.—Motor Transport, 1923.

Kaisen, Peter C.—Assistant in Palæontology, 1923.

Larsen, F. A.—Interpreter and Expedition Agent, 1922-1926.

Loucks, H. A.—Surgeon, 1925.

Lovell, Norman.—Motor Transport, 1925.

Matthew, W. D.—Palæontologist, 1926.

Morris, Frederick K.—Geologist, 1922, 1923 and 1925.

Nelson, Nels C.—Archæologist, 1925.

Olsen, George.—Assistant in Palæontology, 1923-1925.

Perez, J. A.—Surgeon, 1928.

Pond, Alonzo W.—Archæologist, 1928.

Pope, Clifford H.—Herpetologist, Chinese Division, 1921-1926.

Roberts, L. B.—Chief Topographer, 1925.

Robinson, H. O.—Assistant Topographer, 1925.

Shackelford. J. B.—Photographer, 1922, 1925, 1928.

Spock, L. Erskine.—Geologist, 1928.

Teilhard de Chardin, Père.—Geologist, 1930.

Thomson, Albert.—Assistant in Palæontology, 1928-1930.

Wyman, W. G.—Topographer, 1930.

Young, J. McKenzie.—Chief, Motor Transport, 1923-1930.

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A NARRATIVE OF THE EXPLORATIONS OF THE CENTRAL ASIATIC EXPEDITIONS IN MONGOLIA AND CHINA, 1921–1930

PART I

EXPLORATIONS IN MONGOLIA

CHAPTER I

PLANS AND PREPARATIONS

CONCEPTION OF THE CENTRAL ASIATIC EXPEDITIONS

THE original conception of the Central Asiatic Expeditions, of which this volume is the narrative, took shape in my mind as early as 1912. Since 1908 I had been engaged in the study of Cetaceans, principally along the coasts of Asia, but I had decided to abandon that work for the broader field of scientific land exploration.

THE GROWTH OF THE IDEA

I had before me the brilliant predictions of Professor Henry Fairfield Osborn,[1] made in 1900, that Asia would prove to have been a great dispersal

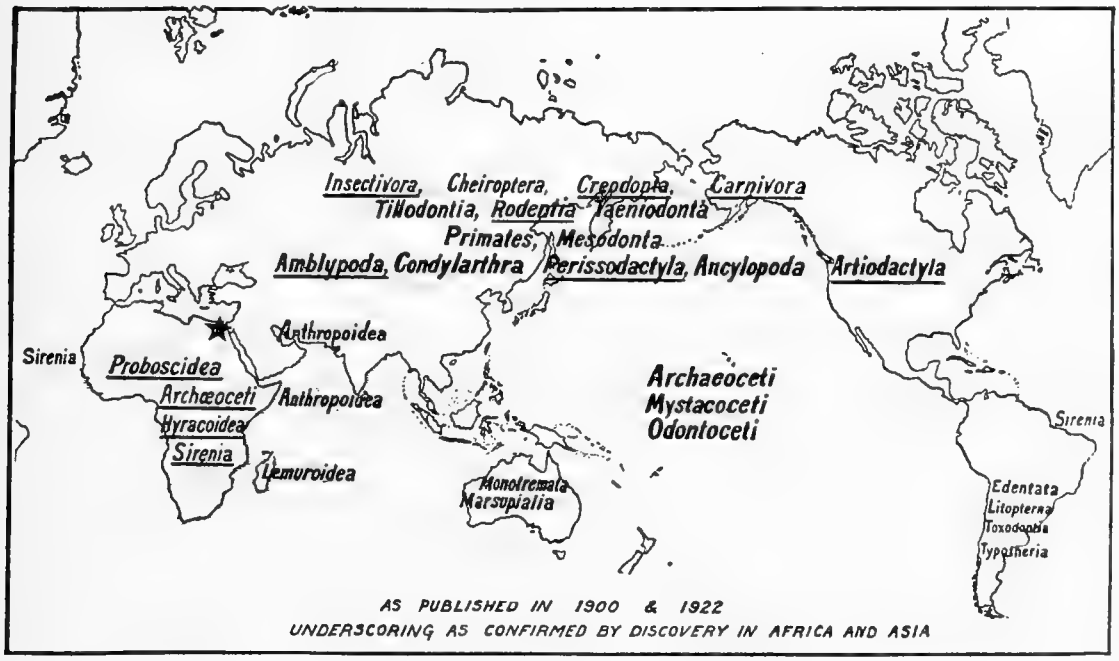


FIGURE 1.—Professor Osborn's Prophetic World Map of 1899–1900, *Science*, page 567, April 13, 1900.

[1] Osborn, Henry Fairfield. 1900. "The Geological and Faunal Relations of Europe and America During the Tertiary Period and the Theory of the Successive Invasions of an African Fauna," *Science*, N. S., XI, No. 276, April 13, pp. 561–574.

center for northern terrestrial mammalian life; also my interest as a mammalogist was stimulated by the extensive collections of new and little-known mammals being brought from China by the Duke of Bedford's Expeditions under the auspices of the British Museum (Natural History).

In 1915 I presented a plan to President Osborn for a series of expeditions which should extend over a period of ten years, and bring to the American Museum of Natural History extensive zoölogical collections from Asia.

As always, I was assured of President Osborn's enthusiastic support, and in 1916–1917 the *First Asiatic Expedition*, under my leadership, explored the little-known province of Yunnan, in southwest China, and the borders of Tibet and Burma. This Expedition not only brought large zoölogical collections to the American Museum but served to crystallize in my mind plans for work on a much broader scale. These collections have been described by Andrews,[1] Bangs,[2] Allen[3] and others.

Having penetrated to that remote region after much difficulty and expense and no little danger, I found myself in the presence of the most interesting problems in every branch of natural history; yet, because of lack of time and of highly specialized training in many sciences, I was unable to take advantage of the opportunities so lavishly offered. Moreover, in all my work as a zoölogist I had felt the lack of expert knowledge in other branches of science. Often puzzling faunistic problems presented themselves, which could have been solved if I had been a trained botanist.

At the end of the First Asiatic Expedition, therefore, I had determined not to miss opportunities again by field researches in a single science, when such infinitely greater results could be obtained by proper organization of an expedition. Also, our exploration along the edge of the great central Asian plateau had fired my imagination and enthusiasm to launch an attack upon that land of mystery; to discover whether or not it was the mother of northern mammalian life.

Service in the World War prevented the immediate execution of the plan, but at the end of the war I was in China with the added experience of having made several trips across Mongolia. The country impressed me greatly. I was convinced that it was the place in which to start the scientific attack upon central Asia. With the view of obtaining a more intimate knowledge of that region, I cabled President Osborn asking permission to carry on zoölogical work there during the summer of 1919. Thus the *Second Asiatic Expedition* came into existence. I spent six months in the desert, grasslands and forests of

[1] Andrews, Roy Chapman, and Andrews, Yvette Borup. 1918. "Camps and Trails in China." D. Appleton & Co., New York.

[2] Bangs, Outram. 1921. "The Birds of the American Museum of Natural History's Asiatic Zoölogical Expedition of 1916–1917," *Bull. Amer. Mus. Nat. Hist.*, XLIV, pp. 575–612.

[3] Allen, Glover M. 1923. "New Chinese Bats," *Amer. Mus. Novitates*, No. 85, pp. 1–8.

PLATE I.

STAFF OF 1922 EXPEDITION IN THE OFFICE OF THE PEKING HEADQUARTERS.
Left to right: Colgate, Wong, Pope, Andrews, Berkey, Morris, Granger and Shackelford.

PLATE II.

1922 EXPEDITION AT TSAGAN NOR, MONGOLIA.

Bottom row: Mongol interpreters and caravan men. Second row, left to right: Morris, Colgate, Granger, Badmajapoff, Andrews, Berkey, Larsen, Shackelford. Top row: Chinese technical and camp assistants.

northern Mongolia and obtained a large collection of mammals representing three faunal areas. A matter of much greater importance, however, was what I learned of the country itself.

At that time a few motor cars were running irregularly between Kalgan, China, and Urga, the capital of Mongolia. The old caravan route was difficult in places and the Ford motor cars which were first used had proved unable to meet the severe demands made upon them. Accidents were frequent and many people had been killed and injured, but Mr. Charles Coltman (who was murdered by Chinese soldiers in 1923) had successfully taken several Dodge Brothers cars to Urga. The fenceless rolling grasslands and the gravel desert made it possible to run off the trail at will and gave me the idea of conducting explorations by automobile. In Tibet and Chinese Turkestan, camels, mules or yaks must be relied upon, but I was certain that motor cars could be used successfully even in the western Gobi.

I returned to New York early in 1920 with the basic plans of the Expedition clearly in mind. The main problem was to be a study of the geologic history of central Asia; to find whether it had been the nursery of many of the dominant groups of animals, including the human race; and to reconstruct its past climate, vegetation and general physical conditions, particularly in relation to the evolution of man. We were to bring to bear upon our problem every branch of science which could possibly assist in its solution. Moreover, these sciences must be represented by men of the highest scientific ability. We must take the men into the field *together*, so that each would have the advantage of assistance from the others; *correlated work* was to be the basis of the scientific organization. Motor cars were to be used in conducting the exploration while a caravan of camels transported the supplies to specified locations. This procedure would give us the great advantage of speed over previous explorers. Headquarters were to be established in Peking, where the Expedition was to be prepared for actual field operations and where the complicated diplomatic and administrative work could be carried on.

FINANCIAL SUPPORT

Such was the 1920 outline of the Expedition. After careful consideration by the President and Trustees of the American Museum, it met with their enthusiastic approval, provided I would undertake to obtain the financial support outside of the Museum, as well as to organize and direct the Expedition. Thus, raising the money rested upon my shoulders. Two hundred and fifty thousand dollars and five years was what I considered necessary in money and time to conduct the work effectively. Later the time was extended to ten years and the finances to six hundred thousand dollars.

The American Museum pledged itself for five thousand dollars a year

and the services of such members of its regular staff as should be detailed to the work. The American Asiatic Association and its official organ, *Asia* magazine, contributed a total of thirty thousand dollars; and after 1924 the Field Museum of Natural History, Chicago, gave five thousand dollars a year, with the understanding that they should have the first series of duplicates of our collections. The remaining funds all came from private individuals whom I was able to interest in the proposed Expedition. At present, thirty-six states and the District of Columbia are represented among the six hundred and fifty-five subscribers; four contributions are from England, one of which is from the Central Asian Society of London; two from China; two from Honolulu and one from each of the following countries: Porto Rico, Switzerland and Norway. A few of the subscriptions are large, but most of them are for small amounts. I tried to make it clear to everyone that we were playing an "off chance" in the scientific race; that the dividends would be large if we won but that by the same token the result might be entirely negative.

WHY MONGOLIA?

It was unnecessary to urge the importance of the project upon any scientist, for the fossil history of central Asia was completely unknown. The British had made some discoveries of interest in India. In China fossil teeth and bones had long been sold for medicine in the drug stores, and a few of these had been

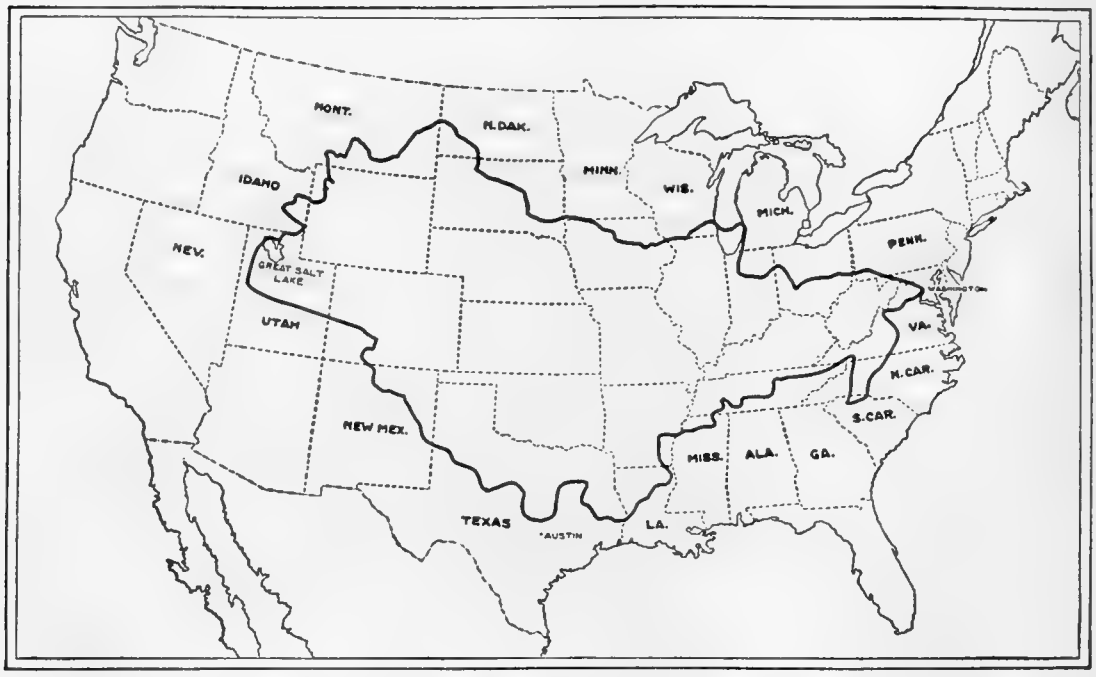


FIGURE 2.—Map of Mongolia superimposed upon map of United States to show comparative size.

studied and described by Owen, 1870; Lydekker, 1885 and 1896; Gaudry, 1872; Koken, 1885, and Schlosser, 1903. By far the most important work was that of Schlosser, but all his material was purchased in drug shops and consisted mostly of isolated teeth without data. Some interesting and important finds had been made in Java, Persia and Asiatic Russia, but these all came from the outskirts of the great continent. Literally the only fossil known from the central Asian plateau was a single "rhinoceros" tooth discovered by the Russian explorer Obruchev[1] in Mongolia during 1894–1896.

As a matter of fact, when it was announced that we were to explore the Gobi Desert for fossils, where attempts in that direction already had been made, our project was ridiculed by some other scientists, particularly in Peking. They pointed out that we would find only a waste of sand and gravel and that we might as well search for fossils in the Pacific Ocean. Our attention was called to the fact that none of the other geologists who had crossed Mongolia had discovered bones, with the single exception of Obruchev. Also I was told it was little short of criminal to waste the time of such eminent geologists as Berkey and Morris in a country where the geology "was all obscured by sand."

However, I felt that I knew Mongolia better than our critics; that in many instances the work of previous explorers had been too much political and too little scientific; that they had not been able to use the modern methods which we intended to inaugurate—in short, that what had been done in the past afforded no criterion as to what Mongolia might yield to our scientists.

PHYSICAL DIFFICULTIES TO BE CONSIDERED

Although Mongolia had been crossed and recrossed by some excellent explorers, mostly Russian, no part of the country had been studied by the exact methods of modern science. Four primary reasons were responsible.

First, Mongolia is isolated in the heart of a continent, and, until recently, a considerable journey was required even to reach its borders. (See Relief Map of Mongolia at end of volume.) *Second*, the distances are great and transportation slow. Mongolia is roughly two thousand miles in length from east to west and twelve hundred miles in breadth from north to south. In all this vast area there is not a single mile of railroad. Transport except in the desert is by camels, ponies and oxcarts. In the Gobi, which extends from west to east through the heart of Mongolia, only camels can be used throughout the year. A camel caravan moves at the rate of two and one half miles an hour and averages about ten miles a day. *Third*, the climate is very severe. During the winter the temperature drops to forty or fifty degrees below zero Fahrenheit, and the plateau is swept by bitter winds

[1] Suess, Ed. 1899. "Ueberreste von Rhinoceros sp. aus der östlichen Mongolei," Mit Anmerkungen von W. Obrutschew, *Verhandl. KK. Russ. Mineral. Gesell. St. Petersburg*, Zweite Serie, Band XXXVI, No. 2.

from the Arctic Ocean. Most types of scientific investigation are impossible at that time, and bare existence demands the strongest constitution. Effective scientific work can be conducted only from April to October. *Fourth*, in the Gobi, which occupies a large part of Mongolia, food and water are scarce, and the region is so inhospitable that there are very few inhabitants.

Motor transport as a solution

I felt certain that all the physical difficulties could be solved by some means of rapid transportation and that without it an expedition such as we had in mind could not be carried on successfully. I believed that the automobile was the answer to the problem. With motors we could go into the desert as soon as the heavy snows had disappeared, penetrate to the farthest reaches of Mongolia, and return before continued cold and snow set in. Thus we should escape the six months of devastating winter when such scientific researches as we had in mind would be impossible. From previous experience, I believed that in cars we could travel about one hundred miles in a day; that is, ten times as far as a camel caravan. Thus we should be able to do approximately ten years of work in one season. As results proved, we did maintain just about that ratio. Moreover, our investigations were made much more effective than they could have been otherwise, for the geologists and palæontologists were able to leave the main fleet at any time to examine outcrops or exposures which were fifteen or twenty miles away. With camels this would have been slow and laborious.

The great aridity and scarce water supply did not greatly trouble us. Often we crossed four or five hundred miles of gravel desert where it was wellnigh impossible even for camels to exist; for with our cars this meant only a few days of travel. The wells on the main caravan trails are usually ten to twenty miles apart, but we could carry sufficient water for several hundred miles. Thus it may be seen how easily rapid transport solved the physical difficulties of exploration in Mongolia. (See Route Map of Mongolia at end of volume.)

POLITICAL DIFFICULTIES

Although the physical difficulties of maintaining a large expedition in such a remote region as the Gobi were great, they were insignificant in comparison with the political obstacles which had to be overcome before we could begin work. In the winter of 1920–1921, Baron Ungern-Sternberg assisted the Mongols in driving out the Chinese. Baron Ungern was defeated by the Bolshevik troops a few months later and the Soviet Government sent soldiers to hunt down the White Russians in Mongolia. The Soviets almost immediately organized a political party of Red Mongols who established a govern-

ment which became more and more a tool of the Soviet. In 1922 the Soviet influence was already strong; by 1923 it was steadily growing and at the time of our Expedition in 1925 the government of Mongolia was entirely in their hands. Although a Mongol Premier and Cabinet were nominally maintained, Buriat and Russian "advisers" controlled the affairs of the country.

It seemed to be impossible for the authorities to understand that we were in Mongolia for scientific exploration and nothing else. We were suspected of political intrigue for the Chinese; of being a commercial expedition in search of gold or oil, masquerading under the cloak of science; of being spies sent by the American Government to prepare the way for a conquest of Mongolia! Everything was believed of us except that we were there for scientific exploration, the purpose we had stated.

It required weeks of work to allay their suspicions so that we might proceed, and many days to fulfill the complicated requirements of passports and other impedimenta. Each year the conditions were increasingly difficult. Had it not been for the assistance of Mr. F. A. Larsen, Mr. T. Badmajapoff and of many Mongol friends who had known me in former years, the Expedition never could have gone into the field.

THE METHOD OF CORRELATED WORK

I had great faith in the method of correlated work. It never had been attempted on the scale on which we intended to operate, and it resulted in practice even better than it gave promise of doing in theory. As we sat in the mess tent at night discussing the day's work, it was most interesting to see how puzzling situations in geology would be clarified by the palæontologist· how the topographer brought out important features which gave the key to physiographic difficulties; and how the palæontologist would be assisted by the palæobotanist or geologist in solving stratigraphic problems. It is doubtful if our archæologist ever could have dated the culture and unraveled the story of the Dune Dwellers without the assistance of the other scientists of the Expedition. Moreover, I believe that this type represents the exploration of the future. To-day there remain but a few small areas on the world's map unmarked by explorers' trails, or which have not been seen from an aëroplane. Human courage and endurance have conquered the poles; the secrets of the tropical jungles have been revealed. The highest mountains of the earth have heard the voice of man. This does not mean, however, that the men of the future have no new worlds to vanquish; it means only that the explorer must change his methods.

Intensive scientific investigation

We stand on the threshold of a new era of scientific exploration which is

just as romantic, just as alluring and just as adventurous as that of Peary and Amundsen, of Stanley and Hedin. In almost every country of the earth there lie vast regions which are potentially unknown. Some of them are mapped poorly if at all, and many hold undreamed-of treasures in the realm of science. To study these little-known areas, to reveal the history of their making and interpret that history to the world to-day, to learn what they can give in education, culture and for human welfare—that is the exploration of the future!

That the growing importance of intensive scientific exploration of a given region is being recognized by the geographical societies is shown by the introductory remarks of the late Dr. D. G. Hogarth, President of the Royal Geographical Society, upon the occasion of my address to that distinguished body in London on November 8, 1926. The President spoke in part as follows:

"He is going to tell us to-night about . . . the organization of almost a new form of exploration—the realization of what I ventured in my presidential address a few months ago to hope would be the work in the future of this Society—that is, intensive study of a particular area. . . . This is, therefore, a very notable moment in the history of the Society; it is about to hear what the exploration of the future is to be. The great journeys of exploration are probably done in almost all the world; the great pioneer lines have been thrown across the continents. What we have to do now is to fill up great gaps between those single lines."[1]

Reconnaissance and specialization

It would have been ruinous to bring a group of highly trained men from America to Mongolia at great expense unless I knew definitely that they could do effective work. The region we were to explore was virtually unknown from the standpoint of our investigations. Therefore, it was obvious that the first season must be strictly a reconnaissance. We must make a general survey of the country without attempting exhaustive work in any one place. The next year then could be one of intensive research, and the amount of time to be devoted to each locality carefully planned in advance. Such intensive work would require a different staff from that for rapid reconnaissance.

As an example, in the summer of 1922, Dr. Walter Granger was the only palæontologist. On the next expedition he was reinforced by three other expert fossil collectors and two trained Chinese assistants, because such rich fossil deposits had been discovered that we needed a large staff for their exploration. We planned in advance the number of days or weeks that could be

[1] Hogarth, D. G. 1927. Introductory remarks of the President of The Royal Geographical Society to Roy Chapman Andrews' paper: "Explorations in Mongolia: A Review of the Central Asiatic Expeditions of The American Museum of Natural History," *Geog. Jour.*, LXIX, No. 1, Jan., pp. 1–23.

devoted to each locality and with one exception maintained the schedule throughout the summer. This method of reconnaissance, followed by intensive work, is the only effective way to avoid loss of time and effort.

In 1922 the Expedition comprised the following sciences: palæontology, geology, topography, photography and zoölogy, the latter including mammalogy, herpetology and ichthyology. Mr. Clifford H. Pope, who devoted his attention to the two last named sciences, did not go to Mongolia but carried on his work entirely in China proper.

In 1923 we concentrated on palæontology, dropped the photographer and one geologist and did little topography. In 1925, another reconnaissance year, we added one more motor expert, three topographers, a palæobotanist, an archæologist, and brought back the chief geologist. The 1925 Expedition totaled forty men. The foreign staff included twelve Americans and two British; and in the native personnel there were thirteen Chinese and thirteen Mongols. In 1928 the Expedition consisted of twenty-two men, ten of whom were foreigners.

Field units

With so many sciences represented, it was improbable that all the men could find work in the same place at the same time. Therefore, the Expedition was divided into several units, each with its own driver, Mongol interpreter, cook and camp gear. Any unit could leave the base camp and maintain itself independently for several weeks if necessary. As a matter of fact, the Expedition was almost continually divided except when we made long marches to new localities; frequently there were four camps from twenty to a hundred miles apart.

Laboratory arrangements

The expense and time involved in preparing the fossil material for exhibition or study was a great problem at the American Museum. The Chinese are naturally so skillful with their hands that we decided in the winter of 1925–1926 to have the work done in Peking. Consequently, a well-equipped laboratory was established at the headquarters under the direction of Mr. George Olsen. He trained our taxidermists and other assistants, and the final preparation of most of the 1925 fossil collection was done in Peking at about one fifth what it would have cost to do the work in New York. The 1928 collection was likewise prepared in Peking, under the direction of Mr. Albert Thomson.

THE STAFF

The organization and equipment of the Expedition had to be carried out simultaneously with the efforts to finance it. Of course, selecting the staff was

the most important single task. The general fitness of a man for the work, as well as his scientific training, needed to be carefully considered, for personality, character and the ability to get on with other men are, perhaps, the most important factors in determining the success or failure of such an expedition.

I may say that our staff could not have been more happily chosen, for during the five seasons in Mongolia there was not a single quarrel. We worked together with a harmony, mutual confidence and lack of personal jealousy which are rare in any organization.

The permanent native staff developed more slowly but not less successfully. As a basis, I had several Chinese assistants who had worked with me on former expeditions. These were added to as the 1921 preliminary trips in China proper brought out men especially adapted for certain types of work. Eventually two of our young Chinese, Kan Chuen-pao and Liu Hsi-ku, showed such unusual ability in fossil collecting that we sent them to New York in 1923–1924 for a year's training in the palæontological laboratories of the American Museum of Natural History. The experiment was entirely successful and they returned to us in China as expert field and laboratory men. Three other Chinese, Kang Fu-min, Chih Sho-lun and Chang Yu-lu, I personally trained for zoölogical work. They became highly efficient in collecting and preparing mammals and birds and later learned the technique of fossil hunting and laboratory preparation. The three cooks and two mess boys were not less efficient in the difficult task of ministering to the wants of the foreign staff. The head cook, Whey, died in 1926, while on a field trip in Yunnan with Messrs. Granger and Nelson. To the end he was loyal to his duty and to the Expedition.

The Mongol caravan men and the three interpreters were old employees of Mr. F. A. Larsen of Kalgan, who engaged them for us. They became devoted members of the Expedition and gathered their families into a single large village, of which Merin, the caravan leader from 1922 to 1927, was chief. This splendid native staff, both Chinese and Mongol, was a factor in the success of the Expedition.

MOTOR TRANSPORT

Equipment

When it was announced that we were to attempt a scientific exploration of the Gobi Desert with a fleet of motor cars, even those men who had driven from Kalgan to Urga said that we were little less than fools. They advanced a dozen reasons why such an expedition could not succeed, but in my opinion every one of them was answerable by preparation and organization. If we took with us a complete assortment of spare parts and expert mechanics who could repair breakage, I felt that we had reasonable chances of success.

For travel in the Gobi, a car must be light, have a high clearance, great

PLATE III.

STAFF OF 1923 EXPEDITION AT IRDIN MANHA.

Bottom row: Chinese technical assistants and Mongol interpreters. Second row, left to right: Granger, Osborn, Andrews, Morris, Kaisen. Top row, second from left: Vance Johnson, Albert Johnson, Young and Olsen.

PLATE IV.

1925 EXPEDITION AT SHABARAKH USU.

Seated, left to right—Roberts, Andrews, Granger, Morris, Berkey, Young. Standing: Robinson, Olsen, Chaney, Butler, Nelson, Loucks, Lovell, Shackelford.

durability, a flexible chassis and not less than a twenty-eight horsepower engine. The Dodge Brothers cars fulfilled these specifications to the letter. We also purchased two one-ton Fulton trucks, but, although these gave excellent service, we eventually sold them in Kalgan because they were too heavy. In certain parts of the desert there is a hard-baked surface of coarse sand. This supported the light Dodge Brothers cars, but the heavier Fultons were continually breaking through the crust. On the 1922–1923 expeditions we used three Dodge Brothers cars and two Fulton trucks. In 1925 the fleet was increased to seven, by the addition of two Dodge Brothers cars; in 1928 the fleet consisted of eight Dodge Brothers motors.

The first cars were all ordinary stock cars; for the 1925 Expedition certain changes were made as a result of our two years' experience. The autos as then used we consider ideal for Gobi travel. All except one had an open "express" body with eight-inch sides of heavy screen wire. The springs, both front and rear, were heavier than on the ordinary commercial car. In addition, on each rear spring, inside, we had iron bumpers lined with pieces of heavy outer tire-casing. Thus, the body of the car when heavily loaded rested on this additional support, making it almost impossible to break a spring when traveling over rough ground. Leather snubbers were also affixed to prevent too great a rebound. The gasoline tanks were increased to contain twenty-one gallons, and four strong hooks were bolted onto the chassis member, front and rear, to facilitate pulling out of mud and sand; also two complete spare wheels were carried on each car, one on either side of the driver's seat. We had one car with an ordinary touring five-passenger body. This being the lightest, I always used it to drive several miles in front of the fleet to scout the road, and for advance explorations.

We found that the 33 x 4.5 Royal Cord tire, made by the United States Rubber Company, gave the best service. Balloon-type tires were not practicable, as we discovered by one season's trial in 1925. Although they held the car up better in sand, they increased the gasoline consumption to such an extent that this alone would rule them out. In addition, they were too easily cut by stones and roots. We carried hundreds of nuts and bolts, almost every conceivable spare part, and the very best tools; our motor experts were highly trained men; thus, short of actual wrecking of the chassis or engine, we were prepared for any emergencies.

The success of the transport is shown by the fact that we used the same fleet of cars for the first two expeditions; that we traveled more than six thousand miles over a virtually unknown country where there are no made roads; that the Dodge Brothers cars did as much as ten thousand miles; that when we returned all the motors were sold in Kalgan, as they stood, with no repairs, within three days, for more than they cost when new in America;

moreover, that the same fleet continued to do service on the Kalgan-Urga trail, in the hands of a Chinese company. The record speaks for itself.

Our explorations had the unexpected result of opening western Mongolia to motor transport. Immediately after our return from the first Expedition, fur dealers came to ask how they could reach certain far-distant trading stations. We told them where to send gasoline and how they could go; now fur and wool buyers who cross the desert use dozens of cars, where only camels had traveled until we came.

Gasoline cases

Packing the gasoline was a great problem, and even yet it has not been solved to our satisfaction. Four thousand gallons were sent out for the 1925 Expedition. Two five-gallon tins fitted into a wooden case which weighed sixty-five pounds; each camel carried six cases. The leakage was great. Straw was wedged between, as well as around the sides of the tins, but even that did not prevent friction. Wherever the straw wore through and allowed the tins to rub against each other, breaks were almost certain to develop. The great difference in temperature between the fierce day-heat of July and August and the cool nights produced a constant expansion and contraction of the tins which was ruinous. Frequently when we opened a case one or both of the tins would be empty or only partially filled. Of course, at every meeting with the caravan we inspected the gasoline carefully and took the lightest cases into the cars to be first used. The leakage on the 1922 Expedition was nearly fifty per cent; in 1923 it was reduced to thirty and in 1925 to twenty-five per cent.

The difficulty might be overcome to a certain extent by using extra heavy tins, but this entails a large expense in having both tins and wooden cases specially made. We considered the advisability of taking the cylindrical steel drums which are sometimes used for shipping gasoline to the Orient. The difficulty, however, of packing cylinders on camels, the initial expense of purchase, the extra weight and the fact that they must be carried back decided us against their use; again, the wooden cases were very important as fossil containers and if they were not available, boards must be carried with which to make boxes. It was cheaper to send out enough extra gasoline to provide for the leakage.

CAMP EQUIPMENT

We have been referred to as a "*de luxe*" expedition because we had the maximum of camp comforts. I may say, however, that there was not one item of unimportant equipment. In the field we were a group of men who worked at high tension for nearly six months. An army cannot fight unless

it is well fed; neither could our men have accomplished what I expected of them unless they were kept physically fit.

I do not believe in hardships, if they can be avoided, for they lessen effectiveness; they are a great nuisance. Eat well, dress well and sleep well is a pretty good rule for everyday use. Don't *court* hardships. Then you can work hard and steadily, and, if a bit of "hardship" does happen in the course of things, you are ready to take it in your stride and laugh while it continues. With us it simply meant sending out a few more camels to carry the extra load of supplies, food and equipment which made just the difference between comfort and discomfort.

Neither do I believe in adventures. Most of them can be eliminated by foresight and organization. My friend Stefansson, the Arctic explorer, has a motto which I am very fond of quoting because it expresses a great deal in a single sentence. He says "Adventures are a mark of incompetence." If the explorer has a clear-cut problem to solve, and an honest desire to contribute something of worth to the world's knowledge, he will prepare against adventures. It will disappoint the newspapers, but facilitate his work. How infinitely more creditable it is to eliminate difficulties through foresight and preparation before they are encountered, than to suffer heroically and leave the work half done!

Shelter

Most explorers find that in every country the natives have developed the best type of dwelling and of clothing for their particular conditions. This is true of Mongolia; the Mongols are nomads who are constantly moving as they follow their flocks or the dictates of their restless spirits. A permanent dwelling would be of little use, as the grazing may be good at a certain place one year but poor the next. Wind and cold are the most serious weather conditions to be met, for there is comparatively little rain in the grasslands or desert. The Mongol tent and the felt-covered yurt are ideal.

The tent is usually made of two thicknesses of blue cotton cloth, light in weight but not very waterproof. The sides sweep down to the ground from the ridge-pole in long curves which present sloping surfaces to the wind at every angle. Thus if the tent is firmly pegged it will resist a heavy wind. The cloth may rip but usually the tent will remain standing. It can be erected in a gale when it would be impossible to pitch a wall-tent. A man can put up a small tent alone. First one side is pegged down and the ridge and poles put in while it lies upon the ground; then with a rope the tent is pulled upright. It will stand in position while the other side is fastened. If a fire is built a little beyond the center and one edge of the tent elevated to create a draft, the smoke will be carried out through the door. During the summer all the edges

can be raised, converting the tent into a pavilion. For a windy, open country where there is little rain, this is an ideal tent.

The yurt is an extraordinarily practical and comfortable dwelling. It is circular with a cone-shaped roof and thus has no flat surfaces to resist the wind. It can be erected in thirty minutes; in the same time it can be taken apart and packed upon a camel. The framework consists of wood lattice sections which can be folded like an umbrella; the felt covering is so excellent a non-conductor that when a fire is lighted in a sheet-iron stove or in the open brazier the yurt is warm even though the temperature drops to forty degrees below zero. In hot weather the felt sides may be rolled up or removed altogether and the yurt is delightfully cool.

Clothing

Our summer clothing was the ordinary flannel shirt and khaki breeches, but the Mongol coat and trousers of sheepskin, wool inside, can hardly be improved upon for winter. We used felt hats and did not find sun helmets essential. Sheepskin sleeping-bags are indispensable. No blankets can keep one warm. We had cot beds for the base camp but when off on reconnaissance trips we slept on the ground. Personally I prefer to do so always. Folding tables and chairs were a great comfort for the main camp.

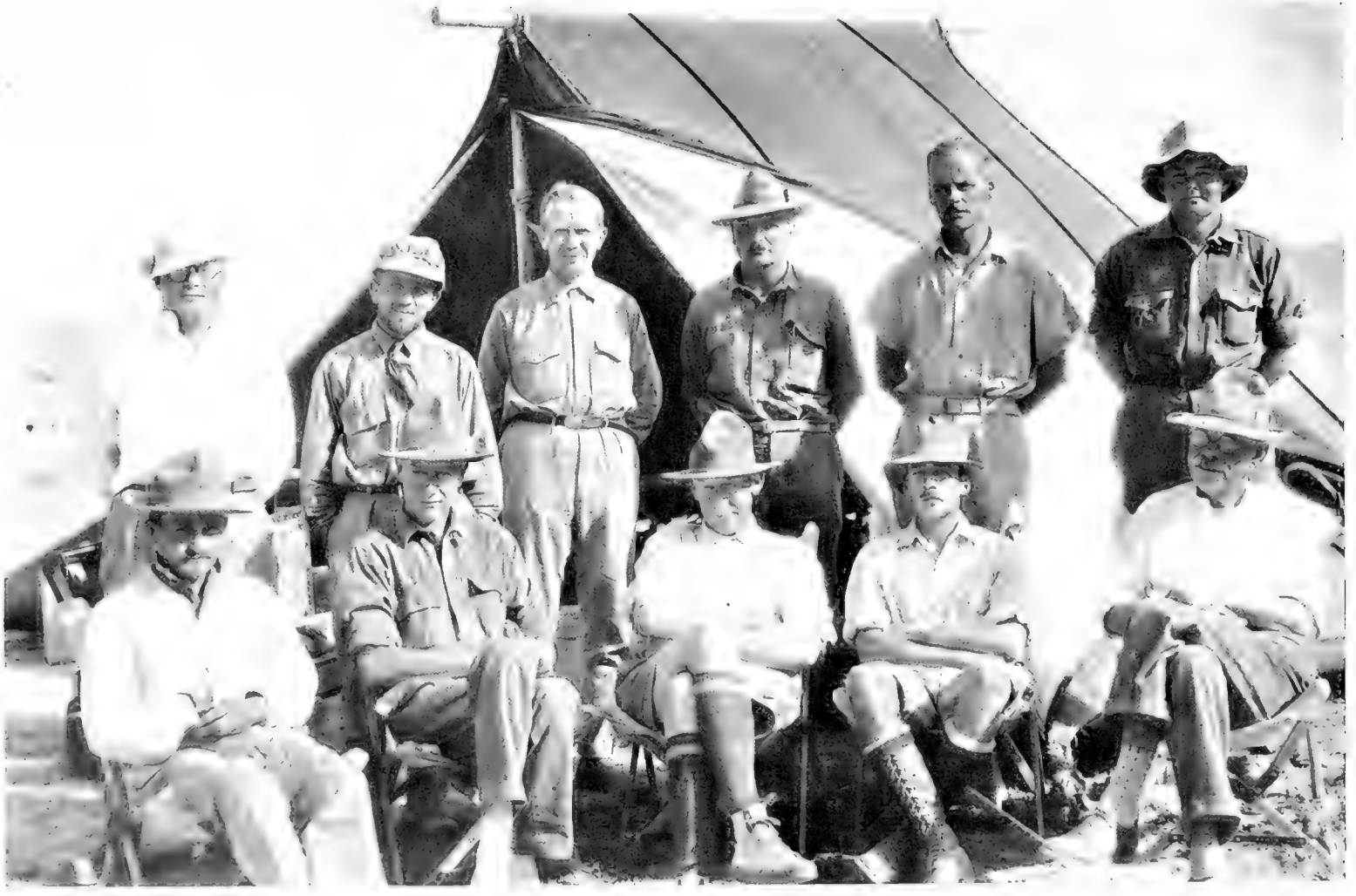
Food

I selected the food with a great deal of care in order to give as varied and healthful a diet as possible. The Mongols live almost entirely upon meat and animal products and raise no grain or vegetables. I brought dried tomatoes, carrots, spinach, beets and onions from New York and we took enough fresh potatoes to last a month. Dried milk and egg powder were easily carried and very welcome. Dried lemon powder was one of our greatest comforts, and made a delicious and healthful drink. We carried no spirits except a few bottles of whiskey for birthday celebrations. This varied diet, the dry clear air, strong sunlight, sparse population and consequent lack of germs, kept all our party in excellent health. On the expeditions, we had virtually no sickness among either the foreign or native staff.

VINDICATION OF PLANS BY FIELD RESULTS

Very soon after the Expedition went to Mongolia, we discovered that my original paper plan for field work was sound in practice. The supporting caravan, carrying gasoline, food and other supplies, was dispatched several weeks in advance of the motor party. Its objective was a well-known place in the desert, six hundred miles from Kalgan, our starting point. The camels traveled slowly, leaving one or two depots of food and gasoline on their

PLATE V.



STAFF OF 1928 EXPEDITION AT HATT-IN-SUMU.

Seated left to right: Perez, Andrews, Granger, Spock, Thomson. Standing: Shackelford, Pond, Eriksson, Horvath, Young, Hill.

PLATE VI

V. V. MEMBERS OF THE STAFF OF THE 1930 EXPEDITION.

A. PÈRE TEILHARD DE CHARDIN, GEOLOGIST.

B. LIEUTENANT W. G. WYMAN, U. S. A., TOPOGRAPHER.

C. DR. A. Z. GARBER, SURGEON.

trail, and had some time to rest before the motor party arrived. Upon connecting with the caravan, we transferred to it all equipment which was not in daily use and took in the cars enough food and gasoline to maintain us until our next meeting with the camels.

Instructing the caravan to follow rapidly, we proceeded in the motors to a suitable region for work and established a central camp. Investigations were carried on in a wide circle about this base. In the meantime, I made advance trips of several hundred miles with one car, exploring the country and estimating its value for future research. When all the scientists had completed their studies at the central camp, the Expedition moved forward to the new region which had been selected and operations were continued. Usually the caravan was behind us, but at times it could be sent on ahead when our moves were short and we remained for a considerable time in one spot. The success of the motor transport depended, of course, upon maintaining touch with the caravan.

At each meeting with our caravan we took supplies of gasoline and food and gave it the collections which had been made. The caravan boxes were especially constructed with sliding tops and the wooden gasoline cases were of convenient size for packing specimens. We used the supplies a little faster than collections were gathered so that there were always several extra camels. This was desirable as sometimes many camels died when it was necessary to send them across long stretches of particularly arid desert.

WEATHER CONDITIONS

The average altitude of the Mongolian plateau is about forty-five hundred feet. The temperature during the winter drops to forty or fifty degrees below zero Fahrenheit, and terrific gales sweep down from the Arctic Ocean and the Siberian steppes. There is a good deal of snow, which is blown into great drifts and makes traveling difficult even for camels. We could not do our work effectively until the snow had disappeared; therefore, our season was limited to the summer months between April first and October first. About the middle of April there is a fortnight of delightful weather with warm sun and little wind. We always took advantage of that period to get well into our field of operations. The first week of May usually sees a return of cold and wind with occasional snowstorms; such weather persists until the middle of June when the real heat begins.

In July and August the temperature during the day may reach 110 degrees Fahrenheit in the shade and 145 degrees in the sun, but the air is so dry that the heat is not debilitating. The nights are always cool or even cold and it was seldom that our sheepskin sleeping-bags were not welcome. The sun almost always shines, and on the desert rain is so infrequent that it hardly

need be reckoned with in preparations for an expedition. In the grasslands north and south of the Gobi there is considerable rain during late July and August. It usually comes in torrential downpours which are soon ended.

MORTALITY AMONG CAMELS

The heavy mortality among our camels was due to the fact that we had to travel during the summer. The Mongolian camel is a cold-weather beast; he cannot stand the heat. He should feed all summer, storing up fat in his humps, and work during the winter. We had to reverse the travel season, with the result that during the winter the animals could not find sufficient food to put them in good condition for the next summer. Therefore, each spring it was necessary to buy thirty or forty new camels to replace those which had died or were too weak to endure a long trip. It entailed heavy expense but was unavoidable, for hiring a caravan was impossible. The price per camel varied with the political situation and the consequent trade. When conditions were fairly peaceful and much merchandise was being transported, we paid as high as seventy dollars, United States currency. At other times we purchased camels at forty dollars each.

CONTACTS AND COÖPERATION

The close association which the Expedition formed with the Geological Survey of China and the Geological Society of China in Peking contributed much, in the first years, to our work. The Geological Survey had been conducting palæontological researches in China proper for four years before we arrived. These were largely under the direction of Dr. J. G. Andersson, and were made possible by funds from Sweden, provided by a research committee headed by H. R. H. the Crown Prince of Sweden. In order not to duplicate their work, and create unhealthy competition, we agreed to confine our explorations to Mongolia or to such parts of China as the Survey designated. This arrangement itself worked admirably, and we had, until 1928, the most cordial coöperation from the Geological Survey, the Geological Society and the government officials.

The first year the Geological Survey offered us a fossil locality on the Yangtze River at the village of Yen-ching-kou, not far from Wanhsien. Our palæontologists worked there for three winters and would have continued for another season had not war and bandits prevented. During the winters I usually returned to America to obtain additional funds for the Expeditions and to stimulate public interest in our work by extensive lecture trips.

CHAPTER II

THE EXPEDITION STARTS

HEADQUARTERS AT PEKING

We could not consider work in Mongolia during the first summer, because it was necessary to make diplomatic arrangements and get the complicated machinery of such a large expedition under way. Therefore, I sailed several months in advance of the main party and arrived in Peking April 14, 1921.

I was fortunate in finding an ideal house for the headquarters of the Expedition. Its former tenant, my old friend, the late Dr. G. E. Morrison, was one of the best-known Britishers who ever lived in north China. His magnificent library, his brilliant writings for the London *Times*, his fascinating personality and his interest in science and exploration made his house a Mecca for travelers of every nationality.

Like all Chinese houses, the compound, which included one acre, was surrounded by high walls. Soon it became a small city in itself devoted to the multiple interests of the Expedition. There were the living quarters of my own family, garages for eight cars, stables, a house for the storage of equipment, an office, laboratories and a complete motion-picture studio.

COLLECTING IN CHINA

It was not until September that the house was finally prepared for occupancy, and in the meantime (June 28) Walter Granger, Chief Palæontologist, and Clifford H. Pope, Herpetologist, had reached Peking. As I have remarked in Chapter I, the Geological Survey of China had invited us to investigate a reported fossil locality near Wanhsien, on the Yangtze River. Granger departed thence in August and remained there all winter. Since I never visited the region I shall leave to him the narrative of his own work. I may say, however, that he carried on under the most difficult and dangerous circumstances. The fact that he was able to do it so successfully indicates that he should have honors for courage and diplomacy, as well as for palæontology.

Since Mr. Pope was unfamiliar with the Chinese language and the methods of collecting fish and reptiles in China, I took him with me on a short

expedition to the Eastern Tombs (Tung Ling) region, eighty miles from Peking. This also gave me an opportunity to train several Chinese assistants in zoölogical collecting. My plan was to have Mr. Pope make a survey of the herpetology and ichthyology in every province of China proper, because Mongolia is so cold and dry that its reptilian fauna is exceedingly limited and I could do the necessary collecting there. The results of Pope's careful and enthusiastic labor already have produced, by far, the largest and most complete collection of fish, reptiles and batrachians that has ever been made in China.

After returning from Tung Ling in August, 1921, Pope went to Anhwei Province and spent the winter of 1921–1922 in the region of the interesting Tungting Lake, Hunan. He made an expedition to Shansi and the border of the Ordos Desert in the summer of 1922. He spent the year 1923 on the little known island of Hainan, southwest of Canton. Later he collected for many months in Fukien Province. At times he conducted his work under the most dangerous circumstances. In 1922, in Shansi, he was in a city that was captured by bandits, yet, by his tact and courage, he not only saved his life and collections but continued his work. On the island of Hainan it was highly dangerous to go beyond narrowly circumscribed limits, because the region swarmed with brigands; yet he remained a year and brought out a superb collection. He learned the difficult Chinese language so well, and has such a sympathetic and thorough understanding of the people, that I consider him one of the best equipped field men for that country whom I have ever known.

In September, 1921, I made a month's expedition to the Tsinling Mountains of Shensi Province, to collect a group of the rare takin, *Budorcas bedfordi*, for the Hall of Asiatic Life in the American Museum of Natural History. In November, of the same year, I went to north Shansi for bighorn sheep, *Ovis ammon darvini*, and stag, *Cervus canadensis kansuensis*.

FINAL PREPARATIONS AT PEKING

The remainder of the winter was spent in making the final preparations for the first Expedition into Mongolia. Everything that could possibly go by the caravan was packed in boxes in order to reduce the load for our cars. The camel boxes were thirty-four inches long by seventeen inches wide and twenty-two inches deep, and had sliding tops. This we have found by experience to be the best size for packing fossils, for a box must not exceed two hundred pounds in weight. The boxes went out filled with food and supplies but returned carrying specimens. Every package had to be weighed, roped and invoiced, so that we knew in which box each article had been placed. When all was ready, the gasoline and equipment were sent by rail to Kalgan, one hundred and fifteen miles from Peking.

At Kalgan, my old friend, Mr. F. A. Larsen, then manager of Anderson,

PLATE

CHINA.
arters.

HEADQUARTERS OF CENTRAL ASIATIC EXPEDITIONS AT 2 KUNG HSIEN HUTUNG, PEKING: COURT
Equipment and stable court; outer laboratory and [illegible] entrance to upper court; servants' quarters

Meyer and Company, placed himself and his great compound at our disposal. Through him I purchased camels, selected the Mongol caravan men and attended to the countless other details incident to the proper equipment of a caravan for such a long expedition into the desert.

On March 21, 1922, our seventy-five camels left Kalgan. The instructions were to proceed along the Kalgan-Urga trail, leave a supply of gasoline at Iren Dabasu (Erhlien), and await us at Tuerin, a large monastery one hundred and fifty miles southeast of Urga. They were to arrive at Tuerin on, or before, April 25; this gave them five weeks in which to travel five hundred and eighteen miles. Since the camels were in good condition, we felt that they could maintain this average of fourteen miles a day.

After the caravan had started, I returned to Peking to superintend the final preparations, arrange for shipment of the five cars to Kalgan, and attend to the multiple final details. The foreign staff had assembled in Peking by April 1, 1922. Granger returned from Szechwan Province after a successful winter at the fossil pits of Yen-ching-kou. Berkey, Colgate and Shackelford arrived from America, and Morris came up from Tientsin where he had been teaching in the university.

The headquarters seethed with activity. Every man was occupied with his own individual preparations for the long summer in the desert. The courtyard in front of the main laboratory was strewn with skins, boxes and equipment, which were being packed for shipment to New York or to go with us to Mongolia. Colgate had the front court filled with cars, and all day the whir of motors being tested and the ring of hammers made it seem like an open-air garage. As if to bid us Godspeed, the lilacs and flowering trees in the courtyards, in bloom almost a week earlier than in any other part of the city, transformed the compound into a veritable paradise.

A farewell dinner was given us by Mr. Albert B. Ruddock, First Secretary of the American Legation, at which Mr. C. S. Liu, then Director-General of Chinese Railroads, became so much interested in our plans that he offered to send the motors and equipment to Kalgan free of charge and give us two private cars for the staff. His courtesy was doubly appreciated, because war clouds were gathering thickly in north China skies and continual troop movements made railroad transport most uncertain. There seemed to be little doubt that the expected clash between Chang Tso-lin and Wu Pei-fu would take place within a few weeks, as indeed it did.

KALGAN, THE ADVANCE BASE

Kalgan is a Chinese city with a strong Mongol influence, and, as it is only ten miles from the foot of the passes which give entrance to the Mongolian plateau, it was an ideal advance base for the Expedition. The altitude at the

railway station is twenty-four hundred and thirty-seven feet above sea-level. Kalgan is the most important gate of the Great Wall and for centuries has been a focal point for the caravan routes which pass to Mongolia, Russia, Chinese Turkestan and regions farther west.

The Chinese name of the town is Chang Chia-k'ou. The foreign name, Kalgan, according to Professor George B. Barbour, 1929, is probably a Russian corruption of the Mongol word *khalga*, meaning a barrier, or gate. The Great Wall blocks the entrance to the Ching Ho (Clearwater River) gorge, and behind it the town straggles along between the hills and the river, finally spreading out on both sides of the stream. The Great Wall, which was started in 214 B. C. by Shih Huang-ti, provides a formidable defense. Of Kalgan's history Barbour remarks:

"The importance of the locality in Chinese history is clear from the long tale of military engagements that took place from the earliest times in attempts to secure control of the district. It is recorded that in 128 B. C. General Wei Ch'ing marched up the Kalgan Pass to subjugate the city of Liang. In one of Genghis Khan's campaigns (1212–1213 A. D.) possession of Hsuan-hua, the walled city twenty miles to the southeast, was hotly contested and a bloody battle was fought at Huai-lai. . . .

"The town itself is of relatively recent date. According to the Great Encyclopædia of the Emperor K'ang Hsi, no city wall existed until the fourth year of the reign of the Ming Emperor, Hsuan Te (1429 A. D.). As it stands to-day—twenty-five feet high, twenty feet broad and four *li* in circumference—it dates from 1573, a fact known from the stamp impressed in bricks used to build it.

"The other walled towns in the area date from the same dynasty. Wan Ch'uan, the next most important as guarding the western pass, was built in 1392."[1]

There are two passes from Kalgan to Mongolia, namely: Hanopa and Wan Ch'uan. The oldest, Hanopa, is so rough that when I took cars over it in 1918–1919 they had to be hauled up by mules. In 1920 enough work had been done on the Wan Ch'uan Pass so that the road was passable for motors under their own power. Passable, but that is about all, for it was such a mass of rocks and ruts that only the strongest car could endure the punishment. Later, a heavy tax was imposed upon all motors, and soldiers did enough road work to make a fairly decent highway as long as carts were prevented from using the automobile track. In the fortunes of war, Kalgan has changed hands with almost kaleidoscopic rapidity during the last five years, and the condition of the road up the Pass varies with each new general in control.

[1] Barbour, George B. 1929. "The Geology of the Kalgan Area," *Mem. Geol. Survey of China*, Series A, No. 6, p. 3.

THE MAIN PARTY AT KALGAN

We left Peking for Kalgan on April 17, 1922. I had been provided by the Chinese Ministry of Foreign Affairs with a formidable-looking document, which was supposed to permit our cars and equipment to leave Kalgan exempt from duty and customs inspection. When I presented it to Chang Tso-lin's soldiers, who were stationed on the road to the Wan Ch'uan Pass, they laughed contemptuously and said: "This is from Peking. We don't recognize Peking."

They insisted that a new permit be obtained from the local military commander. Although it could have been issued in ten minutes, it required three days of constant telephoning and visiting the yamen before it was forthcoming. In the meantime, I sent all our heavy baggage by cart to the village of Miao-T'an, on the plateau, thirty-five miles from Kalgan. The Pass was reported to be in very bad condition, and it was imperative that our cars should go up as light as possible.

Since the Mongols do virtually no farming or manufacturing, their simple needs, such as saddles, cloth, tea, tobacco, boots, tents, etc., are supplied by the Chinese. In Kalgan or Kweihwating, farther to the west, one can purchase all the necessities of Mongol life. Caravans take these commodities into Mongolia and barter for hides, furs, wool, sheep and ponies. From these two frontier cities, trade flows to and from central Asia as it has done for centuries and will continue to do until the desert is crossed by railroads.

CHAPTER III

THE SOUTHERN GRASSLANDS

THE START FROM KALGAN

We left the Anderson, Meyer and Company's compound in Kalgan in five cars at six o'clock on the morning of April 21, 1922. Before we were out of the city gates, we were joined by two other motors. One was driven by Mr. Charles L. Coltman, who was *en route* to Urga on business. In the other were Mrs. Granger, Mrs. Shackelford, and Mrs. Black, who were going to the summit of the Wan Ch'uan Pass to see us safely on our way. I was taking Mrs. Andrews as far as Urga in order that she might get some Paget color photos of the brilliant Mongol costumes for the Expedition. Dr. Davidson Black, of the Peking Union Medical College, who had joined the Expedition temporarily in order to obtain data for his anthropological studies, was to return from Urga with Mrs. Andrews.

The seven cars, finally under way, made a very imposing spectacle as they wound up the long river-bed leading to the plateau. As far as the base of the Pass the country is deeply blanketed with the Pleistocene loess. Centuries of travel in the same cart-ruts have worn the roads into canyons which often lie many feet below the surface. The loess hills teem with human life. Whole villages are half dug, half built into the hillsides but are well-nigh invisible, for every wall and roof is of the same brown earth. These cave-dwellings are delightfully cool in summer and easily warmed during the winter; their greatest disadvantage is the lack of light.

Passing the splendid old city walls of Wan Ch'uan, we reached the foot of the Pass, an altitude of three thousand and seventy-five feet, seven miles from Kalgan. From this point the ascent to the plateau becomes very abrupt, in many places rising three hundred feet to the mile. The highest point, five thousand and seven feet, is reached just where the road breaks through the Great Wall which stretches its length like an ancient gray serpent along the edge of the plateau. In eleven miles the trail rises nineteen hundred and twenty-five feet.

From the Great Wall there is a superb view. Looking backward to the south, mile after mile of rolling hills stretch away to where the far horizon

meets the blue haze of the Shansi Mountains. The waves in this vast landscape have been cut and slashed by the agents of erosion: wind, frost and rain. The hills lie in a chaotic mass with gaping wounds and gullies, painted in rainbow colors, crossing and cutting one another at fantastic angles as far as the eye can see: a stupendous relief map of desolate land.

Forward to the north lies Mongolia, a seemingly limitless stretch of undulating plain swelling to rounded hills between shallow, cultivated valleys. One feels that this is the roof of the world and that beyond the next hillock one can look over the eaves to the rest of the earth spread out below him. One breathes the clean dry air of Mongolia: air so invigorating that it spurs on the modern explorer even as it must have done his primitive ancestors.

GEOLOGY OF THE WAN CH'UAN PASS

The slope to the margin of the plateau, up which we had come, is typical "badland" country, a beautiful example of wind and water erosion. Professors Berkey and Morris could hardly be restrained from plunging at once into the geological problem which it presented, but we could give them time for only a cursory examination. The region was supposed to be Upper Jurassic and barren of fossils, but the geologists were convinced, on structural grounds, of its post-Jurassic age. After our return from Mongolia they gave it further study.

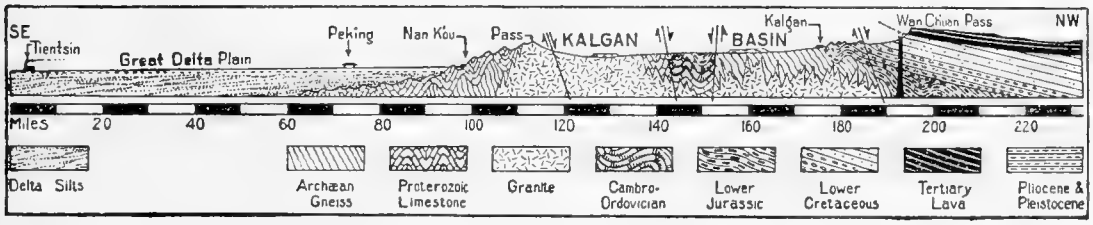


FIGURE 3.—Generalized geologic section from Tientsin to the Wan Ch'uan Hsien Pass. From "Geology of Mongolia."

The geologists have this to say about the entrance to Mongolia: "The edge of the plateau reached by the Wan Ch'uan Hsien Pass, twenty miles above Kalgan, is a true continental divide. From that point toward the interior the average elevation gradually decreases, and one enters the great basin occupied by the Desert of Gobi. While the elevation at the divide is more than five thousand feet above the sea, at the center of the basin, three hundred miles away, it is less than three thousand feet. From the top of the Pass the streams turn inland, and for nearly six hundred miles the drainage is towards the interior."[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, p. 49.

FIGURE 4.—Two cross profiles of the Gobi Basin. From "Geology of Mongolia." Profile A crosses the whole of the eastern Gobi and shows a broad, shallow downwarp between the Arctic and Pacific Divides. Profile B crosses only the northwestern extension of the Gobi lying north of the Altais and shows much stronger warping and block-faulting than does the eastern section.

Altogether there are nearly five thousand feet of exposed sediments. The lower three thousand feet consist of coarse pebbles, chiefly of trachyte and granite porphyries; the upper two thousand feet consist of finer sands and clays which contain fragmentary dinosaur bones. The geologists designated the deposit as the Wan Ch'uan formation. They determined with little doubt that the strata are early Cretaceous. Later, Professor George B. Barbour, of Yenching University, Peking, spent considerable time investigating the Kalgan area and has published the results of his studies in the *Memoirs of the Geological Survey of China*, Series A, No. 6, 1929.

THROUGH THE GREAT WALL AND BEYOND

The Great Wall of China was built to keep the Mongols out and, by the same token, it should have kept the Chinese in, but rich ground for agriculture has lured the Chinese farther and farther into the grasslands of Inner Mongolia. Thus, when our cars roared through the gateway of the Wall, we entered a farmland region dotted with the brown walls of Chinese mud villages where blue-clad peasants were already at work in the fields.

We had had rough going in the Pass—ruts, rocks and steep climbs—but the mud beyond the Wall was our greatest difficulty. Subsequently, we learned that mud is the one thing we need fear for motor transport. When the terrain is dry and the wheels can grip, almost any obstacle can be surmounted. Even sand does not worry us unduly, but wheels that slip and spin on mud are useless. The fifteen miles of road between the top of the Pass and the village of Miao T'an where our baggage was awaiting us, were very bad. As a matter of fact they are almost always bad. The ground is low, and water drains off slowly, so that mud holes may remain for days after even a light rain.

We reached Miao T'an at three o'clock in the afternoon and by four were ready to leave. Bayard Colgate, Chief of Motor Transport, and I were horrified at the loads which were piled upon the cars. They consisted largely of gasoline, photographic equipment and automobile tires which had arrived too late to go with the camels and could not be left behind. Fortunately, the road was smooth and hard—better than I have ever seen it since—and we thought

we might be able to get beyond the area of Chinese cultivation before dark and camp in the grasslands.

Brigands are a very real menace in the Chinese region where the caravan trails converge toward Kalgan and it is highly dangerous to spend the night near one of the villages. In later years we learned to arrive at Miao T'an late in the afternoon and sleep there, so that we might have the whole day in which to travel the brigand-infested area. The experience which we had the first night, while uncomfortable, was valuable. It had begun to drizzle and there were still twenty-five miles to go. We were driving through the inky blackness of a rainy night when suddenly the cars ran into soft ground and became so hopelessly mired that we could only camp where we were. We worked for many hours before they were extricated, but it taught us the lesson that we should never travel at night unless it was absolutely unavoidable.

CHINESE FARM LANDS OF INNER MONGOLIA

For one hundred and ten miles north of Kalgan, in 1922, there were fields owned and cultivated by the Chinese. The Chinese Governor of the district opens a new region for settlement every two or three years, and as soon as the land is sold to colonists more is taken. The average advance is about twelve miles each year. The Mongols are being pushed northward closer to the edge of the desert, for they do no farming and depend for their living upon pastoral pursuits. Millet, oats, wheat, barley and potatoes are the chief products of the Chinese farmers, and the yield is excellent since the land is very fertile.

The members of the Expedition were disappointed that we saw few Mongols even though we were in Mongolia. As a matter of fact, until the area of Chinese cultivation is passed Mongols are virtually non-existent, for they have been driven out by the steady advance of Chinese agriculture. Ten miles beyond the Tabool Hills the village of Chap Ser was formerly almost entirely Mongol, but to-day it has become a collection of Chinese mud huts. After 1922, when motor cars had become an established means of transportation between Kalgan and Urga, Chap Ser was used as a gasoline station and was the first night's stopping place for commercial cars on the northward trip.

BIRDS OF THE SOUTHERN GRASSLANDS

All through the cultivated region we saw great flocks of waterfowl moving northward on their spring migration. Since ornithology was not a part of the Expedition's work, game birds were of most interest to us for they formed a welcome addition to our food supply. I will mention a few of the most abundant. In the fields the bean geese, *Anser fabalis fabalis*, were feeding by thousands on the young shoots of winter wheat. They were rather difficult to approach if one were on foot, but when in a cart or walking behind a pony one

could get within easy shooting range. Although this is the most common goose in north China, strangely enough I have seen only one in the north Mongolian grasslands. There the bar-headed goose, *Anser indicus*, the swan goose, *Cygnopsis cygnoides*, and the graylag, *Anser anser*, breed in small numbers, but the bean goose appears not to nest there.

In the spring, the grasslands of Inner Mongolia are dotted with ponds, many of which disappear later in the summer. These form a convenient halting place for ducks of several species, some of which remain to breed. The mallard, *Anas platyrhynchos*, and the teal, *Anas crecca crecca*, outnumber all the rest, but I have shot the falcated teal, *Anas falcata*, pintail, *Anas acuta acuta*, shoveler, *Spatula clypeata*, red-head, *Nyroca ferina ferina*, and the tufted bluebill, *Nyroca fuligula*, both in the spring and in the autumn, when we have been going to, or returning from, the desert.

The ruddy sheldrake, *Casarca ferruginea*, is omnipresent even in the Gobi, and I shall tell of its peculiar habits in a future chapter. The beautiful burrow sheldrake, *Tadorna tadorna*, we found on almost all the ponds or lakes from the Chinese frontier north to Urga, but when breeding it does not stray far from water, as does the ruddy sheldrake.

There were many species of shore birds on the grasslands, the most abundant being the greater sand plover, *Charadrius leschenaultii*, little ringed plover, *Charadrius dubius curonicus*, golden plover, *Charadrius dominicus fulvus*, lapwing, *Vanellus vanellus*, and gray-headed lapwing, *Microsarcops cinereus*. The two last-named species breed in Mongolia, and the former is one of the most common birds wherever there is a bit of marshland. Its melancholy cry never fails to bring to my mind a picture of the windswept reaches of the northern grasslands, where I have often watched it try to entice me away from the vicinity of its nest by simulating an injured wing. The curlew, *Numenius arquata*, and the avocet, *Recurvirostra avosetta*, are fairly common near ponds, and we could usually pick up a few snipe, *Capella gallinago raddei*, in wet ground.

I must not neglect to mention the beautiful demoiselle crane, *Anthropoides virgo*, which is one of the most abundant and beautiful of the large Mongolian birds. Great numbers were circling in ascending spirals or feeding in the wheat fields beside the road as we passed. These cranes breed in northern and central Mongolia and they are so unafraid that a man can almost touch them, but when in flocks they are not easily approached.

GEOLOGY OF THE SOUTHERN GRASSLANDS

While we were in the area of cultivation it was difficult to do geological work; as the fields became less frequent and finally ended, rock outcrops appeared more often. A gently rolling plain continued until we reached the

Tabool Hills, eighty miles from Kalgan; it varied in elevation little more than one hundred feet. The geologists Berkey and Morris, 1924, found the structure to consist of very ancient granite and metamorphic rocks, which later they realized were a part of "The Great Mongolian Bathylith."

The geologists had a most difficult and strenuous task to interpret the structure correctly and still keep in touch with the rapidly moving main party. I think that none of us realized just what we were asking them to do. They had been plunged into the midst of extremely complicated problems in an unknown country. A correct interpretation at the beginning and a continuous unbroken record of structural changes were of the utmost importance to their future work. They had to solve these problems, at least partially, and preserve the integrity of their record "on the wing" as it were. They could remain for only a few moments at any one spot unless it was of the utmost importance, since it was unwise for them to lag too far behind the motor fleet. The type of men they were is evidenced by the fact that they did not complain but plunged into their well-nigh impossible task with the greatest enthusiasm and energy.

It was necessary to make literally thousands of observations, inspections, judgments and trail studies as rapidly as it was possible to work. To record these observations they kept a route map on which were sketched the course of the traverse and the bordering topography. From aneroid barometer readings a running profile was constructed, mile by mile. On this the geology was sketched in cross sections, representing the underground structure, the succession of formations and the interpretation of their relations one to another. When the Expedition was moving rapidly, such an undertaking was extremely trying and exhaustive work, yet sometimes they did more than one hundred miles of such cross section studies in a single day. (See Figures 5 and 6.)

PREVIOUS PALÆONTOLOGIC WORK NEAR HALLONG OSSO

Even though it was evident that in certain areas thin deposits of sediments overlay the hard rock floor, there were no promising exposures and we did not attempt palæontological investigations. Moreover, in 1919–1920, Dr. J. G. Andersson had done some prospecting in this same region while spending the summers at the Swedish Mission of Hallong Osso, only a few miles from Tabool. He had discovered several small fossil deposits, the largest of which was in an area called Ertemte. While digging a well, the Mongols had come upon a sandy layer at a depth of three meters, containing a fossil fauna consisting largely of rodents. Most interesting among the specimens was the molar of a large beaver-like rodent. At several other near-by localities Doctor Andersson found small deposits, either in well-diggings or in the banks along dry stream-beds.

Doctor Andersson has remarked, "Because of the almost complete lack of natural sections in the gently undulating Mongolian steppe it is very difficult to determine the relation and age even between localities situated close together."[1]

Nevertheless, he provisionally identified two Pleistocene deposits containing *Elephas* and *Rhinoceros*, and Pliocene and late Miocene horizons in several localities. Among the fossils at Ertemte, which he assigned to the Pliocene or late Miocene, were *Castor* and other rodents, *Cervavus* and *Struthiolithus*. An earlier horizon, also Pliocene or late Miocene, was characterized by the presence of "*Aceratherium*, *Hipparion* and *Artiodactyla*, the whole closely resembling the Hipparion fauna of China proper."[2]

Speaking of Ertemte, Doctor Andersson remarks: "When in 1919 I thought that I had identified a beaver molar in this deposit, an identification which has since been fully confirmed, I felt I was facing a palæo-climatic problem of singular interest.

"At present the Hallong Osso region is a typical steppe, where trees are exceedingly scarce, occurring only in small groups in some sheltered rock ravines. Otherwise the whole area is an open rolling grassland. There are no permanent watercourses, and the lakes are more or less saline and entirely dry a large part of the year with a thin crust of salt, which is replaced by water only after occasional rains.

"The finding of fossil beaver, a type indicating forests and water, certainly invites continued research and thoughtful consideration. . . .

"If the Ertemte sand was deposited in an ancient lake, it means, as clearly shown on the map, that the climate of that period was immensely different from that of the present time, for this region is now characterized by treeless vegetation and small residual salt lakes."[3]

THE TELEGRAPH ROAD

Although there are several roads to Urga, the one which we were following, and which the cars all use, is bordered by the telegraph line and is commonly referred to as the "Telegraph Road." It is generally in fair condition except when there has been an unusual amount of cart traffic, which leaves deep ruts. Because of the war between the Chinese and Mongols in 1921, no carts had since used the road, and when we had passed Chap Ser it was like a boulevard. It wound among rounded hills tinged with the first green of early grass, and our cars, in spite of their heavy loads, roared on without an accident.

Our second camp was made at five o'clock in the afternoon, in a beautiful amphitheater where the hills rolled away in gentle yellow-green waves from the

[1] Andersson, J. G. 1923. "Essays on the Cenozoic of Northern China," *Mem. Geol. Survey of China*, Series A, No. 3, p. 46.

[2] *Op. cit.*, p. 47.

[3] *Op. cit.*, pp. 49–52.

granite rocks behind the basin. The early camp gave us time to find necessary items of equipment and to eliminate some of the mud of the previous night. The tents went up like magic, and in half an hour a tiny city appeared in the grassy valley.

EXPEDITION ACTIVITIES

Within a week the Expedition had been so organized that making and breaking camp were short operations. When I had designated the spot for the mess tent, which was always the center of the camp, the foreign staff arranged their tents on one side, and the natives on the other. Every man knew exactly what he had to do, and it was seldom longer than twenty minutes from the time the last car came into camp until all the tents were up and the cooks had a fire started. Then each man set about the tasks pertaining to his particular function on the Expedition. The motor experts refilled all the tanks with gasoline and oil and made a thorough inspection of every car, tightening bolts and nuts, patching tires and putting all in readiness for the next day's run. A record of the mileage, of gasoline and oil consumption, of leakage, and of the terrain was kept by the Chief of Motor Transport.

The geologists set to work at once transcribing their notes of the day's run into more permanent form. Often this carried them far into the night, and it was seldom that the light in their tent was extinguished before twelve o'clock. The photographer reloaded his motion-picture magazines and recorded the subjects photographed during the day. If we were near a promising-looking exposure, the palæontologist made a rapid search for fossils.

I usually despatched the three Chinese taxidermists in different directions to set traps for small mammals, and often Granger and I went with them. Even though we might catch only ten or fifteen specimens, it gave us a continuous faunal line over the region which we were traversing, and often served to delineate the limits of distribution of a species or genus.

The evening hours about the mess table were those that I remember most vividly. Each man had a different viewpoint on the country over which we traveled, and to have such a fund of expert knowledge in so many branches of science upon which to draw was like reading a condensed volume of the "Book of Knowledge." Thus, within a very few days after leaving Kalgan, we had developed an organization of camp life in which the Expedition operated like a well-oiled machine. Moreover, a superabundance of interesting work, good food and congenial personalities contributed to make us a "happy family."

MAMMALS OF THE SOUTHERN GRASSLANDS

After leaving our second camp we ran for thirty miles over pleasant rolling grasslands, where I had promised my companions a glimpse of antelope.

They were mildly skeptical about my tales of the sixty-miles-an-hour speed of gazelles and I prayed for some which would give an exhibition of really high-class running. We did find a herd, but the country was so rough that we could not push the animals sufficiently to make them really run. However, it was sufficient to turn the doubters into my firm supporters.

I killed a young buck, and my companions examined the animal with the greatest interest, for it was their first sight of a Mongolian antelope. The species was the goitered gazelle, *Procapra gutturosa*, which is confined to the grasslands and seldom ranges into the arid parts of the Gobi. The larger size, short tail, heavier body, shorter legs and smaller horns distinguish this animal at once from the desert gazelle, *Gazella subgutturosa hillieriana*. These are the only two species of gazelle in eastern and central Mongolia.

The goitered gazelle is so named because of a great enlargement of the larynx, which produces a prominent swelling on the throat. What purpose this extraordinary character serves I am at a loss to know. Certainly it is not to give them an exceptional "voice," for, when wounded, I have heard them make only a deep-toned roar. During the winter the Mongolian antelope grows a coat of very long, soft hair which is light brown-gray in color, strongly tinged with rufous on the head and face. Its summer pelage is beautiful orange-fawn. The winter coat is not fully shed until the end of May, and the skin of the buck I killed in April was useless as a museum specimen.

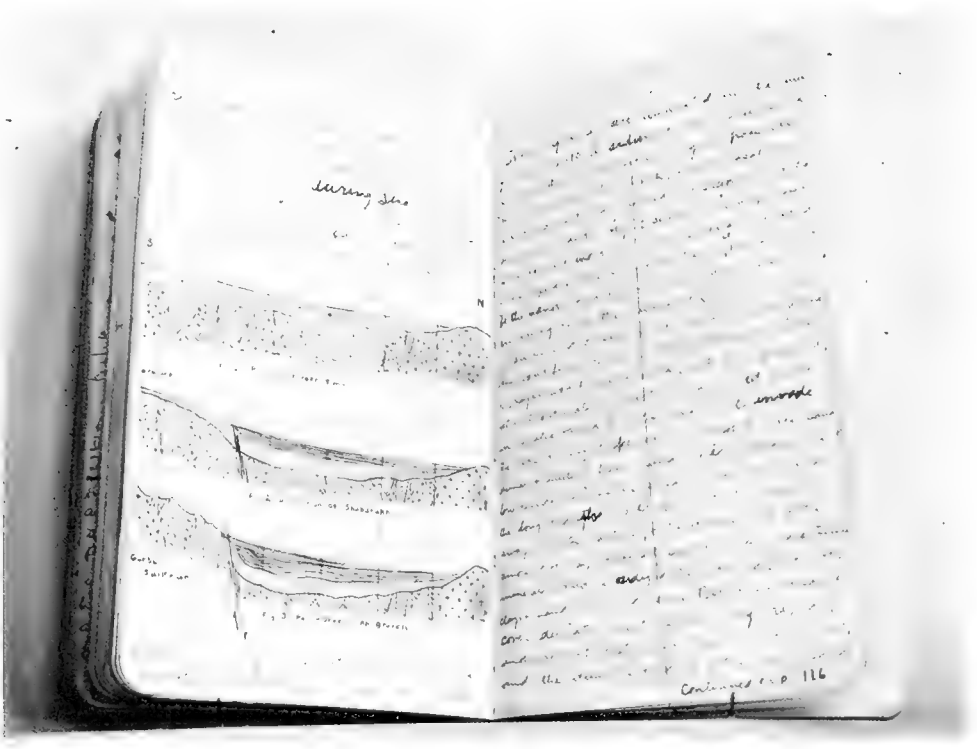
Ten years ago gazelles were abundant at Tabool and farther south to within fifty miles of Kalgan. Like the Mongols, they have been driven from their former range by the steady advance of the Chinese farmer; they may usually be found, however, within five or ten miles of the cultivated area. Both species of gazelles were of prime importance to our Expedition because we depended upon them for fresh meat. Fortunately their flesh is so delicious that we never tired of it, even though hardly a meal passed that antelope meat in some form was not our principal dish. I shall reserve a discussion of their habits for future chapters.

Except for the antelopes, the only visible wild animals in these southern grasslands were the spermophiles, *Citellus dauricus mongolicus*, and occationally a kangaroo rat, *Allactaga mongolica annulata*. Wolves and foxes are natives of this region but they are not abundant; the little field vole, *Microtus warringtoni*, has been caught near Tabool.

The spermophiles, or ground squirrels, were abundant and I shot eighteen or twenty from the car. This species has a wide range in north China and Inner Mongolia, and was originally described by Milne-Edwards in 1867 from specimens taken near Peking. It is confined to the grasslands, and as we approached the edge of the desert near P'ang Kiang it disappeared.

The beautiful kangaroo rat is chiefly nocturnal, but we sometimes saw it

PLATE IX.



A. TYPICAL PAGE FROM THE GEOLOGISTS' DAILY ROUTE NOTEBOOK.

Professors Berkey and Morris carried their geological sections in this way throughout the entire route of the Expedition

B. AN EXPEDITION CAR IN DIFFICULTIES, 1928.

Often an apparently hard crust would break, letting the car sink into soft, sticky mud

PLATE X.

CAMELS BEING WATERED AT A DESERT WELL.

It was from such wells that the Expedition usually obtained its water supply.

running beside the road in the late afternoon. By means of its enormous hind legs it is able to jump six or eight feet and can easily distance a man. The Mongol name for all jerboas is *Allactaga*, which has been adopted as the designation of the genus. The particular species, *Allactaga mongolica annulata*, which we saw near Tabool in the grasslands also ranges southward into northeastern China. In the Central Gobi it gives place to the somewhat lighter-colored species, *Allactaga mongolica*. Ancient Mongolian legends describe the *allactaga* as the horse of the hero Tarabagan, which was transformed into this leaping rodent. The hero himself was changed by his enraged god into a marmot. Thus the Mongol name for the marmot is "tarabagan." Evidences of plague have been found in the *Allactaga*, and natives rather avoid the animal.

CHAPTER IV

THE FIRST FOSSILS

THE GOBI EROSION PLANE

As we approached P'ang Kiang, the first telegraph station on the road to Urga, the country began to change very gradually. The grass became thinner and coarser, and small clumps of camel sage appeared.

The geological structure changed as well. We had come out upon what our geologists have named the "Gobi erosion plane," a surface of extraordinary smoothness developed upon the relatively soft basin sediments. These low erosion plains, so characteristic of Mongolia, are the result of the infinitely slow, but irresistible, forces of weathering which have worn down the mountains and carried off the waste, leaving a new plain carved from a former mountainous region. The Gobi erosion plane is interrupted by many undrained hollows which range in size from two hundred yards to tens of miles in length, and from twenty feet to four hundred feet in depth. The larger hollows have relatively flat floors, though they are never so perfectly level as the Gobi upland, and in almost all cases contain several shallow playas, or wet-weather lakes.

IN THE VICINITY OF P'ANG KIANG

Fifteen or twenty miles before we reached P'ang Kiang the plain began to be dissected by ravines and gullies, and red hills and buttes showed prominently against the skyline. It was ideal country in which to search for fossils and, in order to give the palæontologist an opportunity to inspect the exposures, we camped on the plain not far from the telegraph station.

Berkey, Morris and Granger spent the afternoon visiting the most promising localities, but discovered only one fossil, a fragment of a rodent jaw. Doctor Matthew identified it as an ochotonid, which is not sufficient to serve as an index of the exact age of the formations. In 1928 the deposit was identified by Doctor Spock[1] as Pliocene. These P'ang Kiang beds, where exposed sixty miles farther south, are about five hundred feet thick and, in some places

[1] Spock, L. Erskine. 1929. "Pliocene Beds of the Iren Gobi," *Amer. Mus. Novitates*, No. 394; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 96, pp. 1–8, 1930.

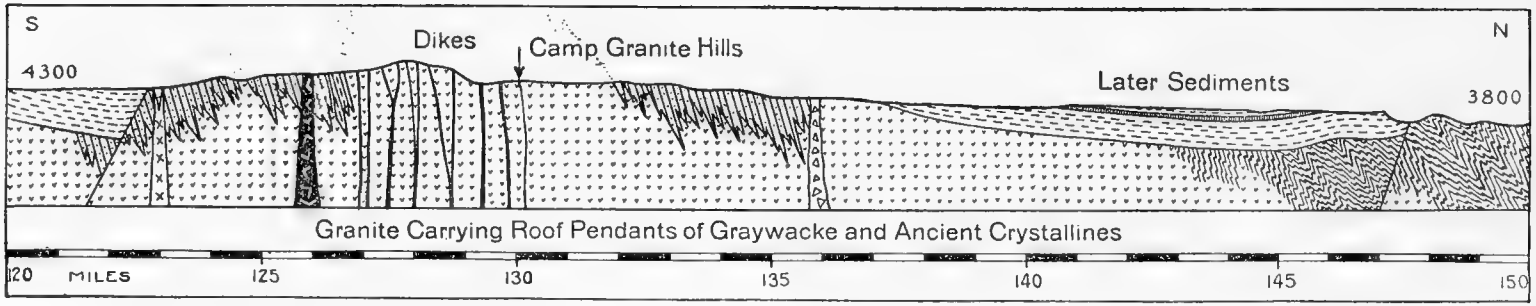


FIGURE 5.—Geologic section through the low rolling country north of the Chahar Mountains. From "Geology of Mongolia."

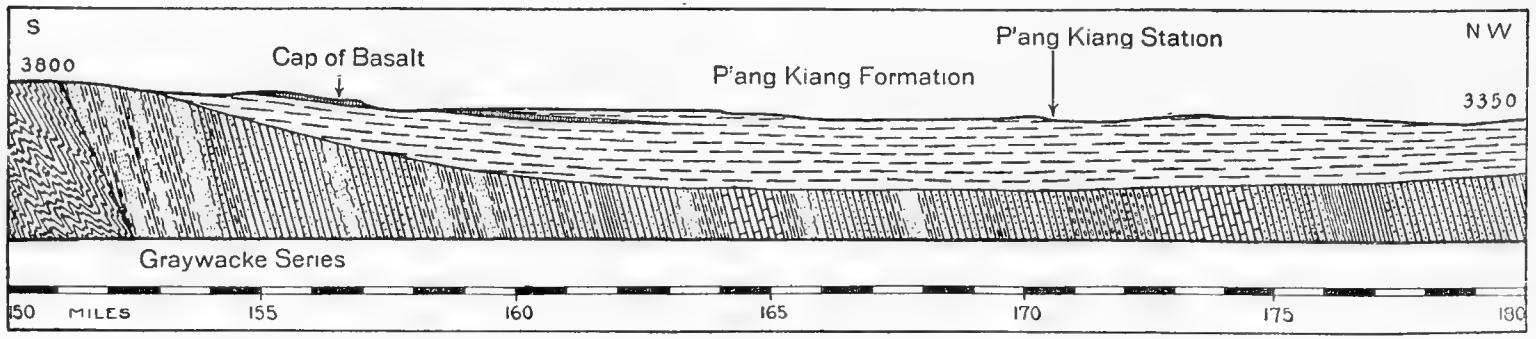


FIGURE 6.—Entering the P'ang Kiang Basin—a typical sediment basin of the "Gobi." From "Geology of Mongolia."

at least, rest directly upon the old crystalline rocks. It is at P'ang Kiang that we always look for "Gobi stones," those polished nodules of chert, agate, chalcedony and jasper which are beautiful in color and shape.

P'ang Kiang boasts of only four mud huts, most important of which is the telegraph station. An inn for the convenience of motor-passengers was constructed in 1923 and for two years did a flourishing business with Chinese merchants traveling between Kalgan and Urga. A more desolate spot hardly can be conceived. The buildings are situated in the lowest part of the basin, their original location being dictated by the presence of a well containing some of the worst water in Mongolia. After enduring this for several years, the Chinese dug two other wells which produce fairly good water, only moderately impregnated with alkali. The Chinese telegraph operator, who had been at this station for seven years, managed to keep quite contented with the assistance of opium.

The "City of P'ang Kiang," as it was often referred to in Chinese papers, had been the scene of important events since I last visited it in 1919. After the Mongols and Russians drove the Chinese out of Urga, they carried the war into Inner Mongolia and for several months P'ang Kiang was the first line of Chinese defense. The long hill slope opposite the telegraph station was pitted with large, horseshoe-shaped depressions reinforced with concrete and arranged in regular lines. These were the "basements" of the quarters in which the Chinese soldiers lived during the long winter of 1921.

P'ang Kiang marks the southern edge of the Gobi Desert, on the Kalgan-Urga trail, if the Gobi can properly be said to have an "edge." The grasslands merge so gradually into the arid regions of the Gobi that it is difficult to say just where the real desert begins. The thinner and coarser grass, the presence of sage and the terrain of fine gravel indicate the approach to an arid region.

THE GOBI LIFE ZONE

At P'ang Kiang one leaves the Southern Mongolian Life Zone characterized by the fauna and flora of the grasslands and enters what I have called the Gobi Life Zone, which is that of a true central Asian desert. There is, of course, a certain overlapping of faunas, but the change is fairly abrupt.

The short-tailed goitered antelope, *Procapra gutturosa*, begins to give place to the long-tailed desert species, *Gazella subgutturosa hillieriana*, which does not range south of P'ang Kiang. Not far from the telegraph station I have seen them both together in the same herd, but that is very unusual.

The grassland spermophile, *Citellus dauricus mongolicus*, does not reach P'ang Kiang and apparently no other species of the genus takes its place. This leaves a break of two hundred miles in the north-south range of the genus, where I have seen no spermophiles during many trips across the Gobi.

A pale-colored jerboa, *Allactaga mongolica*, replaces the darker *Allactaga mongolica annulata* just beyond P'ang Kiang, and a desert hamster which Dr. G. M. Allen, 1925, has described as a new race, *Cricetulus migratorius*, appears in abundance.

The lizards, *Phrynocephalus cf. versicolor* and *Eremias przewalskii*, typical desert species, scurry about the gravel plain, and the brown pit-viper, *Agkistrodon halys intermedius*, which is the only poisonous snake that we have encountered in the Gobi, is fairly abundant.

The Gobi Life Zone is, of course, less well-defined by the avifauna, but one typical species, the sand-grouse, *Syrrhaptes paradoxus*, seldom appears south of P'ang Kiang except during the winter when the extreme cold drives it into northern China.

The chough, *Pyrrhocorax pyrrhocorax*, and the red-leg partridge, or chukar, *Alectoris græca pubescens*, are both inhabitants of the rocky hills of Inner Mongolia but stop short of the desert at P'ang Kiang. The great bustard, *Otis tarda dybowskii*, appears to prefer the grassy plains rather than the more arid regions, but we found it pretty generally distributed all over Mongolia.

SOUTHERN MONGOL TRIBES

After leaving Chap Ser on the way to P'ang Kiang, we had passed through the districts of the Chahar and Sunit tribes of the true southern Mongols. Although the natives nearest the frontier of China have adopted Chinese customs to some extent, still I believe that there is very little intermarriage between the two races and that most of the southern Mongols are of pure blood.

They live in the dome-shaped felt yurts which I have described in Chapter I (p. 16) and, so far as I have observed, have much the same habits as the more northern natives, except that they are by no means as nomadic. It is not necessary for them to move so frequently because there is usually sufficient grass in a single locality to last their flocks through the summer. As a result, whole villages will remain in the same place year after year. This is seldom true of the desert Mongols, who have a regular cycle of migrations. The southern natives, being near an agricultural region, eat much more flour and more vegetables than do the desert people; the latter live almost entirely upon animal products.

The most distinguishing feature of the Chahar and Sunit Mongols is the headdress of the women. This is a network of red coral and silver, with long pendants of coral, silver and turquoise which reach below the shoulders. It is strikingly unlike the Khalkas and other northern tribes where the women dress their hair over a great framework like the horns of a mountain sheep. Although all of the Expedition Mongols were from the Chahar region I have not lived

with the southern tribesmen as I have done with the northerners, and therefore do not feel qualified to compare the details of their home life.

P'ANG KIANG TO IREN DABASU

The Expedition camped only one night at P'ang Kiang. On the fourth morning we had an early start for Iren Dabasu (Erhlien of the Chinese), the second telegraph station on the Urga road, where I had instructed our caravan to leave us a supply of gasoline. Twenty miles from P'ang Kiang we passed a small temple which stands isolated a short distance from a well of excellent water. The place was deserted, and scattered about the plain were dozens of soldiers' uniforms and lama robes, some of them containing weathered human bones. Pariah dogs—grim evidence of the fate of the unfortunate dead—slunk in and out of the gaping walls. It was eloquent testimony of the war which had ravaged this once peaceful land.

As we proceeded northwestward toward Iren Dabasu and penetrated deeper into the desert, the country became more and more arid. There was little vegetation except small tufts of hard stiff grass, camel sage and a low thorny bush about eighteen inches high. We were traveling over a vast plain of Tertiary sediments which, being undissected, offered no prospects to the fossil hunters. Twenty-three miles before we reached Iren Dabasu the road dropped abruptly off the gravel plain, which is almost as level as a table, into a vast basin, in the center of which lies the telegraph station, near a partially dry salt marsh.

The descent to the basin floor was down a steep bluff, the face of which had been deeply eroded by wind and water. It was obviously a place which must be investigated by Berkey, Morris and Granger, so I told them that I

FIGURE 7.—The scarp at Irdin Manha. From "Geology of Mongolia."

would run on to make camp at Iren Dabasu and leave them to follow more slowly. Five miles from the telegraph station we descended another, smaller bluff, into the bottom of the depression which marks the lowest spot in the great Gobi Basin between Kalgan and Urga. The altitude is only twenty-nine hundred and thirty feet.

We ran over to the telegraph station, which consisted of two Chinese mud houses, found our cache of gasoline and learned that our caravan had passed that way two weeks earlier. Then we drove to some gray-white ridges, half a mile to the west, and pitched the tents.

THE FIRST EVIDENCE OF FOSSILS

We were hardly settled before the last two cars swung around a brown earth bank and roared into camp. The men were obviously excited when I went out to meet them. I knew that something unusual had happened because no one said a word. Granger's eyes were shining and he was puffing violently at his pipe. Silently he dug into his pockets and produced a handful of bone fragments; out of his shirt came a rhinoceros tooth, and the various folds of his upper garments yielded other fossils. Berkey and Morris were loaded in a similar manner. Granger held out his hand: "Well, Roy, we've done it. The stuff is here," he said. We were very happy. It was the first definite evidence that our exploration in Mongolia, so far as fossils were concerned, would not be the fruitless hunt predicted by our friends in Peking.

The specimens had been found in the second bluff only five miles from camp and hardly twenty feet from the road. The horizon was certainly Middle Tertiary, but the bones were too fragmentary to permit of a positive identification except in the cases of an aquatic rhinoceros, *Cadurcotherium*, and of a large entelodont. While dinner was being prepared, Granger wandered off along the gray-white ridge that lay like a recumbent reptile west of camp. Even in the failing light he found a few fossil bits and we realized that we had another deposit at our very door.

The following morning, before breakfast, Doctor Berkey discovered a section of the femur of what appeared to be a dinosaur, on the ridge just above camp; a few minutes later Dr. Davidson Black found part of the missing segment in front of his tent. When, after a short time, Doctor Berkey came into camp to ask me to accompany him to the summit of the gray ridge, my excitement had risen to high pitch. Granger was at work exposing the tibia of a large dinosaur; there could be no doubt of it this time!

"This means," said Doctor Berkey, "that we are standing on Cretaceous strata—the first Cretaceous and the first dinosaur known in eastern Asia!"

Thus, four days after entering Mongolia and within two hundred and sixty-five miles of Kalgan, we had discovered Cretaceous strata as well as fossil-bearing Tertiary deposits. All this in a region which we had been told would yield us nothing! Can one be surprised that we were jubilant?

It was not only a personal triumph for Berkey, Granger and Morris, but also for American science, for other geologists had traversed the same formations but had failed to determine the strata correctly. Obruchev, the Russian

geologist, had found a tooth of "rhinoceros" (possibly a titanothere) at the escarpment twenty-three miles south of Iren Dabasu, and took for granted the Tertiary age of the rest of the sedimentary beds.

THE IREN DABASU BASIN

Granger and the geologists remained for a week in 1922 at Iren Dabasu to make a reconnaissance of the deposits; in 1923 they gave it a more careful study. The Iren Dabasu basin, as it is to-day, is a most desolate region. Spotted by conical sandy mounds, sparsely covered with thorny bushes and camel sage, it is a burning desert under the summer sun and an arctic waste in winter. In the lowest part lies a marsh which is sometimes covered by a thin sheet of muddy water, but usually gleams whitely with encrusted salt. Along the edges Chinese laborers, recruited in Kalgan, collect the salt and send it southward to the markets in great caravans of oxcarts. That is done when there is no war. At the time of our visit in 1922, the only human life centered about the mud huts of the telegraph station and the motor inn. Three wells in the basin, which furnish the only water available for miles, have long made it an established camp for caravans. A few miles to the eastward stands a lama temple, but, like the one near P'ang Kiang, it was deserted and partially wrecked.

Iren Dabasu, with all its unattractive surface surroundings, held for us a veritable wealth of scientific treasure. I cannot do better than quote what Doctors Berkey and Granger have said, since it gives the key to the formation of the whole Gobi Desert region:

"Central Mongolia is structurally a series of later sedimentary basins underlain by a floor of more ancient rocks. These basins of later sedimentary strata are separated one from another by stretches of open ground where these same ancient floor-rocks form the surface. This floor has a very complicated structure, its members ranging in age from Archæan to Jurassic time. In mid-Mesozoic time, after repeated earlier mountain folding and extensive igneous activity, the region was peneplaned, and it is this old peneplane surface that has been warped and faulted to make the basins which hold the sediments of later age, now proven to be exceptionally good fossil ground."[1]

The Iren Dabasu basin measures sixty-three miles across from northwest to southeast. We know its limits north and south, and that it extends west more than a hundred miles; it covers an area of at least ten thousand square miles and is one of the largest sedimentary basins of Mongolia. On the north it is bounded by slate hills, on the west by complex old crystalline rocks and

[1] Berkey, Charles P., and Granger, Walter. 1923. "Later Sediments of the Desert Basins of Central Mongolia," *Amer. Mus. Novitates*, No. 77, pp. 1–3; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 7, pp. 1–16, 1926.

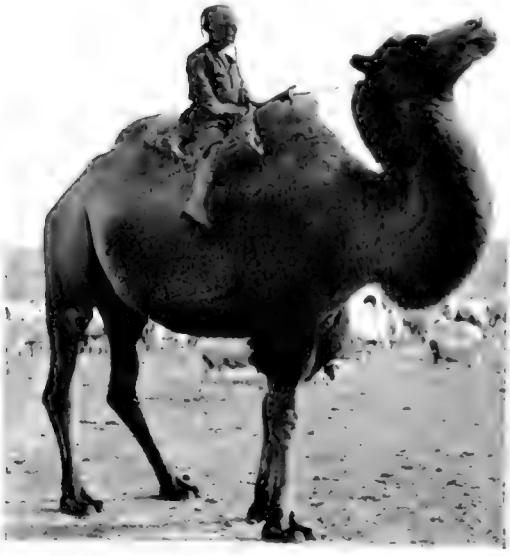
PLATE XI.

THE TELEGRAPH STATION AT IREN DABASU (ERHLIEN).

PLATE XII.

A. TSERIN, MONGOL LEADER OF THE EXPEDITION'S CARAVAN, 1928

B. A PRAYER WHEEL AND A LAMA AT URGA.



C. A FIVE-YEAR-OLD MONGOL SHEEP HERDER.

D. SEWING A PATCH OF LEATHER OVER AN INJURY ON A CAMEL'S FOOT.

on the south by hills of granite, schist and graywacke. It is floored with ancient slates and limestones.

LATER SEDIMENTS OF THE IREN DABASU BASIN

The horizontal Cretaceous beds lie immediately on the slate floor of the depression and have a total thickness of not more than one hundred and eighty feet. Even in the few days which were allowed for the first inspection, dinosaurs of the duck-billed, bipedal iguanodont type, small running dinosaurs such as the ostrich-like *Ornithomimus*, crocodiles and turtles were identified.

This, the first important fossil-bearing deposit which we had discovered in Mongolia, was formally designated by the geologists as the Iren Dabasu formation of Lower Cretaceous age. The geologists found that this stratum, of the Age of Reptiles, was not the only fossiliferous bed in the great depression. Five miles south of the salt marsh, the continuation of the second escarpment which we had descended proved to consist of rather coarse yellow gravel. This contained fragmentary bones and teeth of an interesting water-loving rhinoceros, *Cadurcotherium*, and of an enormous pig, *Entelodon dirus;* the calcaneum of a huge beast which Granger at once suspected to represent the aberrant rhinoceros, *Baluchitherium*, first discovered in Baluchistan, India, 1911, by my friend, C. Forster Cooper of Trinity College, Cambridge; also the remains of a large tortoise, *Testudo*.

The fauna indicates that the gravels are of Lower Oligocene age. The beds are from fifteen to fifty feet thick. They are evidently the result of stream action and the fossils, having been rolled about by swiftly flowing water, are usually in a fragmentary condition. The geologists named these beds the Houldjin formation, from the local Mongol term for the escarpment.

The first escarpment, twenty-three miles to the south, still in the same structural basin, proved to be one of the most interesting and productive of all our fossil fields. The formation represents the Upper Eocene and has been given the Mongol name of Irdin Manha, the "Valley of the Jewels," which contains many translucent quartz pebbles. In addition to several genera and species of carnivora, the fauna includes lophiodonts—small hoofed mammals that were allied to the tapirs on the one hand and to the rhinoceroses on the other—in great abundance, and, most interesting of all, positively identifiable remains of titanotheres. This fulfilled a brilliant prediction of Professor Osborn that we would find titanotheres in Central Asia.

Doctor Granger and the geologists had only a week in which to make their survey of the Iren Dabasu region. It was of such importance that we intended to give it further study, of course, but our first year's work was to be strictly a reconnaissance, to explore and appraise the country with a view to future investigation. More intensive work was done in 1923.

There were still diplomatic arrangements to be made in Urga, and we must connect with the caravan which I had directed to await us at Tuerin, a lama monastery two hundred and fifty miles away. After remaining one day at Iren Dabasu, we left two complete units with the geologists and, on Tuesday, April 26, started for Tuerin with the other three cars.

IREN DABASU TO UDE

About four miles from Iren Dabasu is the boundary between Inner and Outer Mongolia, marked where the road crosses it by a large obo, or conical pile of stones, and a sign in Chinese and Mongol. Sixty-eight miles beyond the frontier is Ude, the third telegraph station on the road. When I first went to Mongolia, Ude consisted only of the telegraph office and one or two other mud houses; in 1928 it boasted a motor inn, several Chinese shops and two yamens or official posts. Passport examination and customs inspection are conducted by the Buriat officials, according to a system inaugurated by the Soviet "advisers." In 1922, when the Soviet influence was only beginning to make itself felt, the inspection was nominal and quickly ended; now, to penetrate Outer Mongolia through the political barriers is exceedingly difficult and, once in, it is even more difficult to get out.

The telegraph station at Ude is situated under the lee of a rough granite area, representing an exposed part of the Great Mongolian Bathylith. It is just in the center of the Gobi Desert, on the Kalgan-Urga trail, being almost equidistant from P'ang Kiang on the south and Tuerin on the north, where the desert begins to merge into the northern grasslands. The surroundings are even more desolate and arid than Iren Dabasu, but, unlike that region, hold no interest for fossil-hunters.

Before the present Mongol Government maintained a frontier guard at Ude, the rough granite hills, to the north, through which the trail runs were a favorite place for bandits to await passing caravans. In 1918 I had a lively fight at this same place. Fortunately we were able to handle our rifles more effectively than the attackers, who, nevertheless, shot much too close for comfort.

JURASSIC STRATA NEAR UDE

Forty miles beyond Ude our geologists discovered a great deposit of Jurassic strata, which is the youngest of the sedimentary groups forming the old floor of the Gobi region. It consists of a series of conglomerates and sandstones of continental type, simply folded or sometimes block-faulted, and quite free from great metamorphism. Similar rocks were found at several widely separated places, and the entire series consists of stream deposits; nowhere is there evidence of marine conditions. The strata are of great

thickness: in one place as much as twenty-five thousand feet. Much to our disappointment, the only fossils which the geologists were able to discover in this series were a few plant remains, chiefly stems which were poorly preserved.

UDE TO SAIN USU

Our heavily loaded cars did not negotiate the road without some difficulty. In several dry stream-beds we encountered sand which gave us trouble. However, we never considered sand to be a very serious obstacle if it was not too extensive in area; short patches merely necessitated hard work in lightening the cars, digging a trail and pushing, by all concerned. We carried wide canvas strips which were laid down in the worst places, but they did not prove to be a great success. Later we discovered that canvas reinforced by transverse pieces of rope was excellent.

After leaving the granite outcrops beyond Ude, the cars ran rapidly up and down a succession of low hills and descended into a vast basin. From the rim we appeared to be gazing across an ocean; not the smallest hill or rise of ground broke the line where earth and sky met in a faint blue haze. Our cars seemed like tiny boats in a limitless brown sea. It is more than sixty miles across the depression, but there is a convenient halting place almost in the center at two wells named Sain Usu (Good Water).

WELL-WATER IN MONGOLIA

The presence of wells makes it possible to travel in Mongolia. The country is criss-crossed by caravan trails, and along the most important routes wells have been dug every ten to forty miles. Some of them are hundreds of years old, for these camel tracks across Mongolia are among the most ancient in the world. The Mongols themselves lead such a nomadic life that their wanderings have taken them into almost all parts of the desert; if they wish to remain at a spot for some time they dig a well. The water-level is not far below the surface, as a rule. If a proper place is selected in the bottom of a dry stream-bed or where a dip in the strata directs drainage to a certain point, one seldom has to dig deeper than twelve or fifteen feet; often not so much. The wells usually are walled with stone or sod, and those along the main caravan trails are kept in fair condition. The water is surprisingly good; only in a few cases was it so strongly impregnated with alkali as to be unpalatable. On the hottest day of summer the water temperature would seldom exceed fifty degrees Fahrenheit, and often it was much less; in a well fifteen feet deep I found ice along the sides on August 15. We seldom boiled the water for drinking unless the drainage was bad or a dead animal was too near for safety.

Beside most of the wells there is a wooden trough for convenience in watering stock; in those which are in frequent use a bucket made of skin attached to

the end of a pole is often to be found. On our expeditions the water problem never worried us, for we were certain to find low ground or dry river-beds where we could dig a well for ourselves if it became necessary. In many parts of the Gobi irrigation would be a simple matter.

We were surprised at the great number of ponds visible from the road after leaving Sain Usu. There had been an unusual amount of snow the previous winter (1921–22) and this superabundance of water was the result. Most of the ponds had disappeared by the end of May.

MAMMALS NEAR SAIN USU

After leaving Sain Usu we saw a great many gazelles of both species, and three times they were mixed in a single herd. The grassland species could easily be distinguished, by its larger size and lighter color, from the desert form; in the remains of their winter coats they looked almost white. I do not believe that they ever interbreed, for among hundreds of specimens which I have shot I never saw one which gave indication of mixed characters. Although the grassland species sometimes ranges into the less arid parts of the Gobi, the desert gazelle apparently never goes into the grasslands.

Among the slate rocks on the north side of the Sain Usu basin we saw a good many gophers, *Citellus pallidicauda*. As I have remarked, between P'ang Kiang and Ude there appears to be an area in which spermophiles are absent. There are other apparent gaps in the range of the genus between Ude and Sain Usu, and between Sain Usu and Tuerin. Careful collecting might show that these are not actual gaps in the range, but only areas where, for some reason, the animals are very scarce.

WITH THE CARAVAN AT TUERIN

Tuerin, where our cavaran was to await us, stands in the center of a vast plain. A ragged mass of granite rocks which rises high above the surrounding country is known as the "Tuerin Mountain." As a matter of fact, the "mountain" is an exposure of the Great Mongolian Bathylith and represents the base of an ancient mountain range, the upper parts of which have been worn away by erosion. It continues some distance to the west in a lower ridge. Forty miles before reaching Tuerin we could see the granite summits standing sharp and clear against the skyline. The peaks themselves are not more than three hundred feet in height, but they rise from a rocky base some distance above the level of the plain.

We came to the mountain just before noon and saw a great caravan camped beside the road. As we drew near, I made out the American flag flying from one of the loads and recognized our boxes. It was our own caravan. Merin, the leader, said that they had arrived only an hour before. They

started from Kalgan March 21, 1922, and we met them April 28, 1922. I had told Merin five weeks before to be at Tuerin on, or before, this day.

It was a great relief to reach the caravan at Tuerin so that we might transfer to it automobile tires and other heavy equipment not in daily use; also to get a new supply of food, for we had left almost all of our provisions with the geologists at Iren Dabasu.

As a matter of fact, we maintained just such close coördination of the caravan and motor party throughout the entire season. The camels were in good condition at the start. We realized after a short experience that, allowing for the necessary time to feed, they could not average much better than ten miles a day when on a march of several hundred miles; on short marches they could be pushed to twenty or twenty-five miles in a day. Using this standard we could usually figure pretty accurately how long it would take them to reach a certain point, except when the maps were in error, as frequently happened. It became a point of honor, however, for the Mongols to bring the caravan to the rendezvous on the appointed day and in not a single instance were they late. We did not have such good success in subsequent years when we were using camels that were in poor condition after several seasons of hard work, and when political conditions had become more difficult.

Instructing the caravan to remain where it was until I had selected a camp site, we ran over to the telegraph station some distance away. There I found a letter from Mr. F. A. Larsen, addressed to "Roy Chapman Andrews, Anywhere in Mongolia." Larsen had been conducting negotiations with the Mongol Government on our behalf, and reported that conditions were favorable for our work but that I must come to Urga before we started west. The letter had been brought to Tuerin by Mr. K. P. Albertson, who had been in Urga for some weeks negotiating for the reconstruction of the telegraph line. During the recent fighting the line had been destroyed beyond Iren Dabasu and there was no communication with Urga except by letters carried by private individuals. The Tuerin telegraph station is the fourth, and last, between Kalgan and Urga, and lies just outside the rocks near a well of excellent water.

We pitched the tents in a beautiful amphitheater walled on three sides by serrated peaks; then I sent Colgate to bring the camels. Shackelford had all his arrangements completed for motion pictures and it was certain that we would never find a more picturesque spot in which to photograph the caravan.

Whenever the caravan arrived at a camp it gave me a thrill. That day I saw it in motion for the first time and it was a sight I shall never forget. As the great white leader bearing the American flag emerged from behind a boulder, the camels, strung out in a seemingly endless line, swung past the tents and broke into three even files; then they knelt to have the loads removed, scram-

bled to their feet again and wandered down the hill-slope to the plain, nibbling at the vegetation as they went.

CARAVAN CUSTOMS

It is amazing how quickly a caravan can be loaded or unloaded. Each box is roped in such a way as to leave a loop at the middle of the upper, inner edge. As the loads are lifted up simultaneously on either side, one loop is pushed through the other, a stick is inserted, and the weight of the boxes holds them in place. When unloading, the stick is pulled out and the loads drop to the ground on either side of the kneeling camel. Very often an antelope horn is used in place of the stick. A hundred camels can be unloaded in fifteen minutes. One man handles twenty camels ordinarily, but for our caravan of seventy-five animals we had five Mongols.

The best pack-saddle consists of a long strip of heavy felt wound between and over the two humps and held in place by a light wooden framework. The Chinese often use oblong burlap bags stuffed with straw, in place of the felt, but they are not as satisfactory.

The camels feed during the day on the sage and thorny desert vegetation; they do not like green grass and will not thrive if forced to eat it. At night they are tied by the nose strings, face to face on either side of a long picket rope, where they chew their cuds and sleep contentedly.

FALSE SPRING WEATHER

Since our first night in Mongolia the weather had been delightful. During the day it was warm enough to be comfortable without a coat; and at night the temperature dropped to only a little below the freezing point. We had been fortunate in striking the period of fine weather which usually begins about the middle of April and continues for two or three weeks. We call it the "false spring."

On the afternoon of our arrival at Tuerin a tremendous "wind devil" swept down upon us from the north just at sunset. It came like a tornado, bringing a swirl of yellow dust and sand. We were well-nigh blinded, but even above the roar of the storm sounded the clatter of tins and the sharp rip of cloth as our camp was half demolished. The wind devil whirled through the mouth of the amphitheater and across the plain with the speed of a race-horse, but it left a heavy gale roaring among the rocks. The temperature dropped thirty degrees in a few minutes, and from that day until the end of June we were seldom without our sheepskin-lined coats.

CHAPTER V

TUERIN

FAUNAL ZONES BETWEEN KALGAN AND URGA

TUERIN is particularly interesting to a zoölogist, for there the desert begins to merge into the northern grasslands and there one enters the North Mongolian Life Zone. The mammalian fauna resembles that of the southern grasslands, differing only specifically in most cases, but defined by the presence of a few mammals which are never found south of the desert.

Just beyond Urga, one hundred and fifty miles to the north, the North Mongolian Zone meets the edge of the Mongolian-Siberian Zone; this is sharply delineated by the forest line where it encroaches upon the rolling grasslands. Thus, when crossing Mongolia from the south to the north on the Kalgan-Urga road, we pass through, or meet, four distinct faunal zones: From Kalgan to P'ang Kiang, the South Mongolian Zone of the grasslands; from P'ang Kiang to Tuerin, the Gobi Zone of typical desert life; from Tuerin to Urga, the North Mongolian Zone of grasslands; and from Urga northward the Mongolian-Siberian Zone characterized by many Siberian species and heavy forests of larch, spruce, pine, birch and maple.

FAUNA OF THE TUERIN AREA

At Tuerin our traps yielded many small mammals only specifically unlike those of the Inner Mongolian grasslands. A five-toed, long-eared jerboa, *Allactaga mongolica*, was abundant; this species has a wide range in similar country to the west and extends northward right up to the forest margin. We also obtained examples of the three-toed jerboa, *Dipus sowerbyi*, which is a typical desert species and in this region reaches its northern limit at Tuerin. The hamster, *Cricetulus griseus obscurus*, which we caught at Tuerin, extends along the northern edge of the desert for a long distance to the west. Another hamster, *Cricetulus migratorius curtatus*, is a semi-desert form and has been described as a new race by Dr. Glover M. Allen. He says: "This appears to be one of the *Cricetulus migratorius* group, the center of whose range is western Asia to the borders of western Europe, and is apparently another of

the species of that area to have made its way through the Altai region into the eastern Gobi Desert. In addition to being apparently the most eastern member of the *migratorius* group yet discovered, it is also the shortest tailed."[1]

Tuerin is the southern limit of the marmot, *Marmota bobak*, in this region. It is essentially a grassland species and I have never seen it in the desert. The marmots have all been exterminated in the immediate vicinity of the road, but their deserted burrows were abundant not far from the telegraph station. They begin to appear in numbers twenty miles north of Tuerin where there are fewer Mongols. I will describe their interesting habits in later pages.

Wolves and foxes

Along the road to Tuerin we saw only one wolf and one fox. From specimens which we obtained farther to the west, Dr. G. M. Allen, 1929, has identified the wolf as *Canis lupus laniger* and says that it does not seem to be very different from the typical European race. He thinks that the name *laniger*, based on the wolf of Tibet, is also applicable to those of Mongolia and north China. I cannot understand why there are comparatively so few wolves and foxes in Mongolia. On the prairies of western America, coyotes and foxes are common even to-day; in Mongolia the thousands of antelope and smaller mammals and birds would furnish an abundance of food, and yet one may travel for hundreds of miles without seeing a wolf or a fox. As a matter of fact, they most often appear along the main caravan trails, which are usually well marked by the carcasses of camels and oxen. Certainly killing by Mongols could have little or no appreciable effect upon the numbers of wolves and foxes, for the population is much too sparse and on the plains the natives seldom hunt them unless they have been annoying the sheep herds. The Mongols do not use poison, as a rule, for it is too difficult to obtain and they are afraid of killing their own dogs, which are highly prized. At Tuerin I saw several abandoned wolf dens among the rocks. The animals seldom go far away from the rocky country; the foxes have similar habits. In 1930, at Wolf Camp, forty miles southeast of Iren Dabasu, wolves were abundant, and thirteen were killed in the immediate vicinity of our tents. We saw many more wolves here than in any other part of Mongolia.

Birds

The interesting sand-grouse, *Syrrhaptes paradoxus*, was still with us at Tuerin, although it is essentially a bird of the desert. We had seen it in great flocks in the most arid parts of the Gobi, about Iren Dabasu and Ude, where

[1] Allen, Glover M. 1925. "Hamsters Collected by the American Museum Asiatic Expeditions," *Amer. Mus. Novitates*, No. 179, pp. 3–4; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 52, pp. 1–7, 1926.

our cars frequently frightened them from their dust baths in the road. The great bustard, *Otis tarda dybowskii*, which had but recently arrived, breeds in great numbers on the Tuerin plain. The Mongolian larks, *Melanocorypha mongolica*, filled the air with song. This lark is a favorite cage bird of the Chinese, in fact, thousands of nestlings are caught yearly to be sold in the markets of north China. Not only does it have a charming song, but it is a mimic of no mean ability. Several larks that I had in Peking could imitate the mewing of a cat so perfectly that I was often deceived, and my police dog, Wolf, was kept in a state of perpetual excitement.

Hundreds of demoiselle cranes, *Anthropoides virgo*, were performing their mating antics on the plain. It was most amusing to watch the male strutting about the apparently indifferent female, leaping into the air and doing a veritable dance with wings half spread. These birds lay their eggs in late May or early June, but make no nest.

The beautiful rock pigeon is pretty well distributed over Mongolia. It looks exactly like a domestic pigeon except for the white rump patch which is conspicuous in flight. The bird is an inhabitant of rocks and mountain foothills and is not found in the desert.

Of all the birds at Tuerin, the one which surprised and interested us most by its unusual habits was the ruddy sheldrake. There is no water, except wells, within many miles of Tuerin, and yet about twenty sheldrakes had taken up their residence among the granite rocks. All day long we could hear their mournful notes as they circled about camp and contested for a favorite roosting place on one of the highest peaks. Often we would see one silhouetted against the sky on the very summit of a ragged pinnacle looking more like an eagle than a water-bird. We found them throughout the desert. There, I suppose, they feed as do cranes upon grasshoppers and other insects, but I am sorry to say that I surprised one pulling lustily at the decaying flesh of a defunct camel. Although we did not actually find their eggs, I am certain that they were nesting among the rocks of Tuerin, for the twenty or more birds were obviously in pairs. Later, in every marsh of the western Gobi we would see them glowing like molten gold among the green grass and reeds.

The sheldrakes seemed to have little fear of the great golden eagles, *Aquila chrysaëtos daphnea*, which soared about the Tuerin peaks. This eagle, as well as that which I provisionally identified as the steppe eagle, *Aquila nipalensis nipalensis*, had been present all the way across Mongolia. They were abundant, particularly in the grasslands, and at every camel carcass along the road we could be certain of seeing two or three.

Mongolia has a great number of raptorial birds. Half a dozen species of hawks are common, but the black-eared kite, *Milvus lineatus*, is most abundant. We never camped, even in the most arid parts of the desert, but that many

kites continually circled about the tents waiting for scraps. At Tuerin there were literally hundreds of kites nesting among the rocks.

TUERIN MONASTERY

Just to the west of the road lies the Tuerin Monastery. My first sight of it years ago left me with the impression that it was the most remarkable group of human habitations I had ever seen. Familiarity in later years with the great monasteries of Mongolia has not changed that feeling. Coming upon them suddenly, as one usually does, from the empty vastness of the rolling plains, their outlines enhance the atmosphere with medieval strangeness and mystery. The Tuerin Monastery is by no means one of the largest, but it is very picturesque. Three temples lie in a bowl-shaped hollow among the granite outcrops, surrounded by hundreds upon hundreds of tiny narrow houses painted white with red trimmings. To the east rises the ragged mass of granite peaks; on the other three sides the "city" is encircled by huge piles of *argul* (dried dung) which had been collected by the priests or bestowed as votive offerings by devout travelers. Vast as the supply was, it would require many more tons to warm the houses of the lamas during the bitter months of winter. The dwellings and temples are built of sawn boards brought from the forests north of Urga.

LAMAISM AND ITS INFLUENCE IN MONGOLIA

More than a thousand lamas live in the Tuerin Monastery. They have a well-organized system of church rule, and are (1922) directly controlled from Urga, which is only one hundred and fifty-two miles away. I have never studied lamaism and, rather than quote what I have gleaned from the ignorant priests, I would prefer not to discuss such a complicated religion. Suffice it to say that most of the lamas themselves have only the vaguest impression of what it is all about and are chiefly concerned with material things. As a whole they are a bad lot, and I believe that the decadence of the Mongol race is more directly attributable to the introduction of this pernicious religion than to any other cause. This I shall again touch upon in Chapter XII.

It has been estimated that more than two thirds of the male population of Mongolia are lamas and I should say that this statement is not exaggerated. The Mongols are fanatically superstitious but they certainly are not deeply religious. Their chief concern is to pay sufficient respect to the gods and the forms of their religion to ensure themselves from the wrath of the deities. The majority of the lamas are human parasites, mentally and morally degraded, who exist by contributions from the lay population. To ensure such maintenance they must keep superstition active in the minds of the populace. This is not a difficult matter with such simple, uneducated people as the Mon-

gols. During my years in Mongolia I have often cured various forms of illness or injury, but the lama doctor never failed to require payment for his prayers. Usually the patients would admit that it was my medicine that had given them relief, but were convinced that the priest would call down curses on their sheep and ponies if they did not meet his demands.

Since Mongolia has come under Soviet influence the Russians have made strenuous efforts to break the power of the lama church. As yet they have not dared to use force to that end but have confined their propaganda to speech-making, posters, writings and other more subtle methods of undermining lamaism. They have not allowed the appointment of another Hutukhtu, or Living Buddha, since the death of the last one in 1923, and have virtually eliminated the lamas from important governmental affairs.

I doubt that the influence of the religion can ever be eliminated from the life of the ordinary Mongol. He is a child of nature with a simple, uninquiring mind. Many natural phenomena he cannot explain except on the grounds of divine interference and, to his mind, this answers everything satisfactorily. Superstition was instilled in his ancestors for centuries and has been handed on to him. Since he has inherited his primitive instincts his belief in the power of the lamas will persist, although it may be forbidden by law.

As usual, the interior of all the Tuerin temples was scrupulously clean. I have never known a dirtier people than the Mongols, but they must believe that "cleanliness is next to godliness" so far as their religious edifices are concerned. In the main room of the central and largest temple was a statue of the Buddha, draped with gay-colored silken strips; below it was an altar bearing ever-lighted candles. Rows of prayer mats facing the center were arranged upon the floor, and on the left of the altar was a cushioned chair for the chief lama. The walls were adorned with paintings representing the "wheel of life" and various gods and goddesses—some of them lewd in the extreme. Streamers of red and blue silk hung from the ceiling and about the door.

Near the temples and at other convenient spots were more than a dozen prayer wheels. Each wheel is a hollow cylinder of varying size, standing on end and embellished with Tibetan characters in gold. The wheels are sometimes filled with thousands of slips of paper upon which is written a prayer or a sacred thought and each revolution adds to the store of merit in the future life.

Near the Tuerin Monastery there were obos, or religious monuments. The obo is a conical pile of stones built on a hill or promontory or some other commanding point. There are thousands of them in Mongolia. Those near temples often have swords and spears of wood fixed on the summit. On almost every caravan trail, where it crosses any particularly high or difficult

hill, an obo is built, and is replenished by every traveler who reaches that spot in safety, so that often they are of enormous size. My own camel men never passed an obo without tossing a stone or two upon the pile. Often hatas are hung on obos. The hata is most important in Mongol life. It is a strip of light blue silk two or three feet long and a foot wide. It is a token of friendship or good will. When a Mongol wishes to pay respect to an official or an ordinary individual, or to make a request, he usually first presents a hata.

MONGOL WARFARE

Tuerin had been the scene of a massacre of Chinese soldiers during the terrible winter of 1921 when Baron Ungern-Sternberg assisted the Mongols to drive out the Chinese. Everywhere we saw heaps of empty rifle shells, cartridge clips and parts of uniforms. Four thousand Chinese soldiers had been almost annihilated by three hundred Mongols under the lead of a famous Mongol general whom I met several times in Urga.

Baron Ungern had sent Cossacks to attack the Chinese, but the Mongol general wanted the fun himself. By doing miles of hard riding across the plains they reached Tuerin at daylight, before the Russians arrived. With only a few minutes to rest their ponies they attacked; the general himself told me the story of the fight. "We rode at full speed through the camp," said he, "killing every one we saw. Then we rode back again. The Chinese ran like sheep and we butchered them by hundreds." After the first few rushes the Mongols did not waste their ammunition, but clubbed the frenzied Chinese with their rifles or sabered them as they ran. Those who escaped the first onslaught fled into the desert half clothed. The Mongols hunted most of them down and virtually all whom they missed froze to death within a few hours. The temperature was forty degrees below zero. (See Chapter XII.)

As I heard the story from the barbaric-looking general, sitting between two attendants with peacock plumes streaming from their hats, I thought of how like the ancient Mongol warfare was this episode of the twentieth century. Except for the modern weapons, the tale might have been a thousand years old. Had not wild hordes of Mongols, unhampered by a commissary, and making almost superhuman marches, conquered all of Asia and half of Europe in the twelfth century? Then as now, if there were no mare's milk or meat they tightened their belts and laughed at hunger. Thirst was their daily portion; he was not a man who could not go thirty-six hours without water and fight at the end. It was their heritage from Genghis Khan, an awakening of the old fighting spirit which is only dormant in the Mongol of to-day.

It was this same Mongol general who rode with ten followers from Urga to the stronghold of the False Lama in the Black Gobi in 1923. This almost

PLATE XIII.

A. A PRE-MONGOL GRAVE AT TSETSENWANG, 1922.
These graves exist in many places in the grasslands of Outer Mongolia.

B. A PRE-MONGOL SKELETON IN A GRAVE AT TAIRUM NOR, 1928.
The remains of a skirt composed of bits of fossil shells may be seen about the middle of the skeleton.

A. EXTERIOR VIEW OF THE PRISON AT UIGA.

B. PRISONER CONFINED IN A COFFIN.

Fortunately this barbarous method of punishment is no longer used in Uiga.

mythical figure had established a small kingdom of his own and ruled independently of any authority. The general rode openly into the fortress, demanded to see the False Lama and shot him with an automatic pistol. By this courageous act the usurper's power was broken and his adherents scattered.

FROM TUERIN TOWARD URGA

My plan was to go to Urga to conclude the diplomatic arrangements and give Shackelford an opportunity to photograph a great festival which was to take place on May 9. The caravan was to wait at Tuerin until it was joined by Granger and the geologists who had remained at Iren Dabasu; I was to send them instructions where to join us.

Following the storm on the evening of April 28, the day of our arrival at Tuerin, the temperature hovered about the freezing mark even during the day. Although the sun shone in a cloudless sky, a bitter wind continually swept across the plain. On May 1, black clouds hung about the northern horizon and there was every indication of a blizzard, but we had no snow at Tuerin. The next morning dawned clear and warm, and we started for Urga in one heavily loaded car.

For thirty miles north of Tuerin the great plain spreads out on every side like a gently billowing sea. At first it seems as flat as a table, for the swells merge indistinguishably into a level whole. It is only when some approaching object dips for a little out of sight as a depression swallows it up that one realizes the unevenness of the land.

Seventy miles beyond Tuerin we stopped at a Mongol yurt for tea. In the distance snow-capped hills shone against the sky, and a dazzling white blanket lay over all the land. The snow was four inches deep, and soft and slushy. It was well-nigh impossible to keep to the road and soon we were badly mired. Unloading and hard digging became the order of the next two hours. When the car was clear we did not go a hundred yards before it was up to the hubs in another mud hole. Fortunately the snow lay in a narrow strip only ten miles wide, and beyond it the road stretched out brown and hard.

NORTHERN GRASSLANDS

We came then to the rolling grassy hills and never left them until we reached Urga and the Tola River. These are the true northern grasslands. Now they were bare and brown, but when I first saw them in early August they were luxuriant with long sweet grass. Then, horses and cattle grouped themselves into moving patches and fat-tailed sheep dotted the hills like drifts of snow. Great masses of bluebells covered the valleys with an azure blanket, and all the hills were dotted with brilliant bits of color from myriads of flowers.

BOGDO OLA FORESTS

Twenty miles from Urga we saw the low mountain range which bounds the southern side of the Tola valley. Coming as we did from the south, we could see, on the mountain tops, a ragged skyline of sentinel larches made by the edge of the forest which covers almost every slope on the northern side. The moisture-laden winds sweep down from the Siberian steppes and precipitate their rain on the northern slopes in veritable deluges, all through the summer months. There must be, however, some other reason, not so obvious, why even in the midst of the forest area most of the hills are bare on the southern face.

The mountain facing Urga is known as the Bogdo Ola and is a very sacred spot. This mountain with its wonderful forest of spruce, larch, pine, birch and maple was a preserve for many kinds of game. Roe deer, wapiti, moose, boar, and musk deer found a safe refuge, for the mountain was patrolled by hundreds of lamas and it was worth one's life to fire a gun or kill any animal or bird within the sacred precincts. For a foreigner even to go into the forests a permit was necessary in the days of the Hutukhtu.

TOLA RIVER

The road to Urga descends a mile-long slope to the rock-strewn valley of a stream tributary to the Tola River, which empties into Lake Baikal. In the old days there were half a dozen Chinese huts at the ford. These might be called the "suburbs," for the Sacred City is still a score of miles away. The last twenty miles was very bad going for the car. Mud, stones and ruts make some parts well-nigh impassable if there has been a little rain, and it is difficult to leave the road because of the river on one side and steep slopes on the other.

We crossed the Tola by what was known as the "Russian Bridge." The river is less than a hundred yards wide at this point and flows swiftly between low banks bordered by willows. It has an abundance of fish, many of which are the typical Lake Baikal species. Huge lake trout, four or five feet long, and many other fish are taken in nets and sent to Urga for sale to the Chinese and other foreigners. The Mongols do not eat fish.

After crossing the river we turned westward down the Tola valley and passed the barracks which in the old days were occupied by the Russian guard and later by Chinese troops. They stood deserted and partly wrecked, but they have since 1922 been rebuilt and occupied by Soviet soldiers.

CHAPTER VI

URGA, THE CAPITAL OF MONGOLIA

THE SACRED CITY OF THE LIVING BUDDHA

THE city of Urga is strung out for five miles along the north bank of the Tola River. One comes first to the Chinese quarter, Mai-mai-cheng, then to the Russian section and finally to the city proper. It is not the same Urga that I first saw in 1918, but the change is more internal than external, and I cannot better the description I wrote in 1921:

"Far up in northern Mongolia, where the forests stretch in an unbroken line to the Siberian frontier, lies Urga, the Sacred City of the Living Buddha. The world has other sacred cities, but none like this. It is a relic of medieval times overlaid with a veneer of twentieth-century civilization; a city of violent contrasts and glaring anachronisms. Motor cars pass camel caravans fresh from the vast, lone spaces of the Gobi Desert; holy lamas, in robes of flaming red or brilliant yellow, walk side by side with black-gowned priests; and swarthy Mongol women, in the fantastic headdress of their race, stare wonderingly at the latest fashions of their Russian sisters.

"We came to Urga from the south. All day we had been riding over rolling, treeless uplands, and late in the afternoon we halted on the summit of a hill overlooking the Tola River. Fifteen miles away lay Urga, asleep in the darkening shadow of the Bogdo Ola (God's Mountain). An hour later the road led us to our first surprise in Mai-mai-cheng, the Chinese quarter of the city. Years of wandering in the strange corners of the world had left us totally unprepared for what we saw. It seemed that here in Mongolia we had discovered an American frontier outpost of the Indian fighting days. Every house and shop was protected by high stockades of unpeeled timbers, and there was hardly a trace of Oriental architecture save where a temple roof gleamed above the palisades.

"Before we were able to adjust our mental perspective we had passed from colonial America into a hamlet of modern Russia. Gayly painted cottages lined the road, and, unconsciously, I looked for a white church with gilded cupolas. The church was not in sight, but its place was taken by a huge red building of surpassing ugliness, the Russian Consulate. . . .

"For two miles the road is bordered by Russian cottages; then it

debouches into a wide square which loses its distinctive character and becomes an indescribable mixture of Russia, Mongolia and China. Palisaded compounds gay with fluttering prayer flags, ornate houses, felt-covered yurts, and Chinese shops mingle in a dizzying chaos of conflicting civilizations. Three great races have met in Urga and each carries on, in this far corner of Mongolia, its own customs and way of life. The Mongol yurt has remained unchanged; the Chinese shop, with its wooden counter and blue-gowned inmates, is pure Chinese; and the ornate cottages proclaim themselves to be only Russian."[1]

RUSSIANIZATION OF URGA

When I visited Urga in 1919 it was still in the days of Mongol freedom; one came and went as freely as though one were on the open plains. Before 1922, all that had changed. Entering Urga in 1922 and in 1925 was an ordeal and leaving it was worse. At the outermost limits of Mai-mai-cheng, Buriat soldiers piled upon the car and for hours one had to submit to an inspection of passports, searching of baggage and person, questioning by Secret Police and a dozen other annoyances. In short, one was treated as a spy and a generally undesirable character. With evident reluctance the authorities may admit that at first sight there is no reason to detain the traveler, but from the moment he enters Urga until he leaves, one or more spies are detailed to watch and report upon his every movement. Woe to him who has not destroyed every scrap of written or printed matter before he falls into the clutches of the Secret Police; even carrying our best American magazines may land him in jail for a night, until the authorities have perused them in the hope of finding "seditious literature."

In the old days almost every race of Central Asia might be seen on the streets of Urga. It was a Mecca for the pilgrimages of devout lamaists, and in its kaleidoscopic mass of life and color the city was like a great pageant on the stage of a theater, with the added fascination of reality. But now there are not so many dashing horsemen on the street; not so many strange costumes and half-dazed nomads from the steppes of Tibet or the deserts of Turkestan. Their places have been taken by Russians and swaggering Buriats, and the great open square is daily filled with squads of awkward Mongols being drilled as soldiers. Machine guns stand where lines of camels knelt before and the prison is filled to overflowing. Even the name of the city has been changed. Officially "Urga" is no more—now it is "Ulan Bator," the Red City!

Most of this happened after 1922, for at that time the Russian-Buriat influence was just beginning to be strongly felt. The Buriats are a northern tribe of Mongols who live within the borders of Siberia and are Russian subjects. Most of them speak Russian and have been brought up with Russian

[1] Andrews, Roy Chapman. 1921. "Across Mongolian Plains." D. Appleton & Co., New York. Pp. 62–64.

customs and ideas. The obvious plan of the Soviet is to make Mongolia a Buriat country and thus far they have been remarkably successful.

By 1925, Soviet domination in Outer Mongolia had become so complete that the four reigning khans were virtually stripped of their power. One or two of them had "voluntarily" relinquished all their land and princely claims and reduced themselves to the status of ordinary citizens; in return for this sacrifice they had received—nothing!

The Mongols themselves like the change no better than the foreigner. The most dominant characteristics in the Mongol nature are independence and love of freedom; to be bound by such useless restrictions in the Sacred City has robbed him of what he loves most in life. As a result many of the pure-blood Mongols have gone to the open plains and Urga has become a Buriat city under Soviet domination.

DIPLOMATIC NEGOTIATIONS

Our entry into Urga was facilitated by the good offices of Messrs. Larsen and Hansen of Anderson, Meyer & Company, who persuaded the officials to postpone the inevitable questioning and examination until the next day. Then began a fortnight's negotiations for permission to continue our work, which nearly shattered my nerves. It is needless to detail the process, but suffice it to say that had it not been for Mr. T. Badmajapoff, Adviser to the Minister of Justice, and for Mr. F. A. Larsen, we never would have been able to satisfy the government requirements.

The officials seemed to feel that it was not reasonable to suppose that such a great expedition with so many camels and motor cars, and obviously costing such a large sum of money, could be coming to Mongolia merely for scientific work; that we must have some ulterior purpose in view, such as searching for oil or gold, or even spying for the Chinese government.

Colgate had to drive to Tuerin with two Mongols and a Secret Service agent to "inspect" the caravan. He did the three-hundred-mile trip in a day and a half, and on his return reported all well in camp.

On the same day, May 6, the American Consul arrived from Kalgan with a letter from Granger, whom he had seen at Iren Dabasu. It brought the first news of the discoveries which I have already detailed in Chapter IV. It may be recalled that I had left for Tuerin the day after our arrival at Iren Dabasu. Granger's letter is of such historic interest that I quote it in full:

"Iren Dabasu, May 3, 1922.

"Dear Roy:

"We're still here but expect to leave for Tuerin by the 6th.

"This has been an unusually interesting spot. 1) Cretaceous with dino-

saurs. 2) Eocene or Oligocene with a small mammalian fauna including a beast very much like *Titanotherium*. 3) Miocene or later with a small and very fragmentary collection of remains, but including a remarkable beast, either the same as or closely related to Forster Cooper's *Baluchitherium*, one of the largest land mammals.

"Berkey is writing an announcement for *Science* and a letter to Professor Osborn, both of which will be held until we see you. This is the first Cretaceous to be noted in Eastern Asia and is an important discovery.

"Everything is all right in camp. We may have a time getting all our equipment and the four Chinese in the cars but will manage it somehow. Expect to take about three days to Tuerin.

"Mr. Sokobin is in to-night and takes this to Urga.

"Hastily yours,

"Walter Granger."

This splendid news from the party at Iren Dabasu renewed my patience in trying to convince the officials that we were in Mongolia to do only scientific exploration and had no interest whatever in politics or the commercial aspects of the country.

FESTIVAL OF THE MAIDARI

During the time that the diplomatic negotiations were going on we had an exceptional opportunity to see the great festival of the Maidari which took place on May 9, 1922. The Maidari, or Coming Buddha, is a most sacred Bodhisattva. A gilded image of him reposes in a splendid temple in Urga. On this day, which is kept in honor of his incarnation, his image is placed on a huge throne, smothered in decorations and drawn through the streets as the central figure in an elaborate procession.

The festival began in the early morning, for the Maidari had a long way to go. At ten o'clock, when we reached the main square, the procession had not yet appeared, but the air was throbbing to the boom of drums and the deep notes of conch-shells. As the waves of sound beat down upon us, we could see in the east a great mass of color, advancing slowly. Soon groups could be distinguished; then slender lines and huge umbrellas blazing in the sunlight. Every shade of the spectrum was repeated a hundred times in the gorgeous pageant of marching lamas. As the procession neared us, I recognized the Premier in a robe spun of gold with a priceless sable hat upon his head. Beside him were the four reigning khans, or kings, of Mongolia, and behind them a double row of princes, dukes and lesser nobles dressed in dark blue gowns with brilliant cuffs and streaming peacock plumes.

The great throne bearing the Maidari was shaded by a silk umbrella of

rainbow colors and surrounded by the highest lamas, resplendent in cloth of gold. From the throne silken ropes led off to flanking lines of red- and yellow-clad lamas, bearing huge umbrellas of bright-hued silk. Behind the Maidari came other lamas, thousands of them, and women dressed in rich gowns with ropes of pearls about their necks and hair ornaments of gold studded with precious stones. Almost ten thousand lamas were with the Maidari, and two or three thousand men and women and children followed. When the procession reached an open square, overlooked by the great temple on the summit of the hill, the throng was halted and the lamas seated themselves upon prayer-mats in converging masses of solid color, with the Premier in the center and the highest lamas flanking the Maidari.

The seated priests were given tea and food while a red-robed lama in the Maidari's chariot energetically thumped the heads of the populace with a long stick padded at the end. There could not be the slightest doubt in the mind of the suppliant that he had been blessed after the ball at the end of the stick landed on his head, for at times the officiating lama took huge delight in bringing it down with force enough to rock his victim. Nevertheless, thousands of people crowded about the throne and the priest laid on lustily for an hour.

The splendor of the princesses and wives of the higher nobles made one gasp for breath. The wife of one of the great khans in particular was the most magnificently adorned creature I have ever seen. According to the custom of the northern Mongol women, she had her hair plaited over a frame into two enormous flat braids, curved like the horns of a mountain sheep and reinforced with bars of gold. Each horn ended in a gold plaque, studded with precious stones, and supporting a pendant braid like a riding-quirt; this was enclosed in a long cylinder of gold, heavily jeweled. On her head, between the "horns," the lady wore a gold filigree cap studded with rubies, emeralds and turquoises, and surmounting this, a "saucer" hat of black and yellow, richly trimmed with sable. Just above her ears great ropes of pearls hung from her gold cap halfway to her waist. Her skirt and jacket were of rich silk; over all was thrown a dazzling brocade coat with prominent puffs upon the shoulders.

The princesses had a dignity that was very becoming to their high estate. They were accorded none of their husbands' privileges, so far as the procession was concerned, but, each accompanied by a servant, moved majestically in the midst of the vast crowd. Now and then they stopped to talk quietly for a moment with a friend or to acknowledge the deep salutes from both men and women by a slight bend of the head and just the ghost of a smile.

DRESS OF THE NORTHERN MONGOLS

Urga is in the region of the Khalka tribe of which Genghis Khan was a member and which, since his time, has been the dominant tribe in the north.

The dress and hair adornment, which I have described in speaking of the princesses at the Maidari festival, is true in a lesser degree for all these northern women. In everyday life the long hair braids are not enclosed in the cylinders of gold and silver, and the ropes of pearls or beads are used only when in full dress. The silver filigree cap and the hat of black and yellow are always worn. The skirt and jacket are usually replaced with a less ornate gown, but this is always of brilliant color; in fact, color is just as characteristic of the Mongol women as it is of the Burmese.

The men are hardly less brilliant than are the women, but their dress is more simple in design. The lamas have robes of either flaming red or yellow, cuffed with blue. Beneath the gown, which is gathered at the waist by a twisted sash, are loose trousers. On their feet they wear great boots with pointed, turned-up toes and flat soles, always many sizes too large for the wearer, but padded with socks of wool or fur as the weather grows colder. The boots are designed for warmth and comfort in the saddle, for a Mongol never walks if he can possibly avoid it.

On the head both men and women wear a hat which looks like a saucer. It has upturned edges of black velvet and a narrow cone-shaped crown of brilliant yellow. Two broad red streamers are usually fastened to the rim at the back, or, if the wearer be an attendant to a nobleman, a short plume of peacock feathers to the peak of the crown.

The lamas, of course, always shave the head. The lay Mongols are called "black men" because the hair grows long and is twisted into a queue. The black men usually wear a gown of plum color with sky-blue cuffs.

RELICS OF THE URGA THAT HAS DISAPPEARED

Urga is so filled with interesting things and personalities that it would require several chapters to give even a sketch of them all. We explored the city pretty thoroughly during the time that we were waiting for the diplomatic negotiations to be concluded and Shackelford exposed many thousands of feet of motion-picture film. When we left he carried with him a record of Urga life such as never can be duplicated, because already much of it has disappeared, due to changes in the political situation.

In 1922, the Living Buddha was in very bad health; he died the following year. He was blind and few people except his most intimate advisers saw him. I called to present a Savage 250–3000 rifle, which was gratefully received by one of the high lamas who doubtless disposed of it immediately for a good price. In return I was given a photograph of the Hutukhtu and his wife.

At that time his quarters were two hideous foreign houses of Russian style, painted a bright orange. He changed his dwelling place frequently and used to be particularly fond of a green-roofed collection of temple-like

PLATE XV.

A. MONGOL WOMEN OF THE KHALKA TRIBE AT URGA.
This is the typical headdress of the women of northern Mongolia.

B. THE GREAT TEMPLE IN THE LAMA CITY AT URGA.

PLATE XVI.

A. A MONGOL GIANT AT URGA

This man was exactly [illegible] tall and weighed 397 pounds.

B. THE MAIDARI PROCESSION IN URGA, 1922.

The Expedition made the first motion pictures of this festival. It has now been abolished.

buildings surrounded by a palisade painted white and green. This stood beside the bank of the Tola River amid a beautiful grove of birch trees just at the foot of the Bogdo Ola. Another larger palace stood on the flat meadow half-way between the river and Urga. It was of Chinese architecture and was fronted by a huge and extremely ornate gate.

The garage of the palace interested me immensely because in it was a car, purchased by the Hutukhtu, that had made the first trip from Kalgan to Urga. In the garage stood a huge Fiat truck with an enclosed body capable of carrying twenty people. This had recently been purchased for eighty-five hundred dollars but probably never would be used. There were two Franklin cars and the old Ford relic which was the historic car to make the first crossing of the desert. Several other automobiles of the vintage of twenty years ago reposed in one corner of the building; one was a French three-wheeled affair with a carbureter two feet square projecting far out on the left side. How the machine ever reached Urga is a mystery. Several other relics were too broken and covered with dust even to be identified. The only really workable thing in the entire garage was a motorcycle.

A short distance from the great palace in the meadow were the remains of the Living Buddha's zoölogical garden. At one time I believe he had quite a collection, chiefly of Mongolian animals, but all had died except an elephant and a wapiti stag.

AGREEMENT WITH THE URGA GOVERNMENT

The last of my many meetings with the Cabinet and officials took place on May 17, 1922, at nine o'clock in the morning. Then I signed, with the Premier and Minister of Foreign Affairs, the agreement over which we had bargained for a fortnight. Passports already had been obtained for every member of the party, for the cars, chauffeurs, guns, rifles and revolvers. This had required days of work and the expenditure of more than a thousand dollars. But at last it was ended and the final political barriers to our journey to the desert had been removed. We were to be allowed to carry on our expedition and in return we guaranteed to fulfil certain conditions. Among these was the obligation to take a government official with us to see that we carried out our agreement. The official designated to go was our friend, Mr. Badmajapoff, with whom it had all been arranged previously. Badmajapoff is a Buriat who has had considerable experience with the great explorer, P. K. Kozloff. He is a master of Oriental diplomacy and moreover is a charming companion. His presence on the Expedition was most agreeable to us all and made for us a firm friend, who in later years did much to help me steer a safe path for the Expeditions among the political rocks which barred the way to the great open spaces of the Gobi Desert.

Mr. F. A. Larsen was to accompany us as interpreter. Mr. Larsen had been in Mongolia nearly forty years, and had taken a most important part in the affairs of the country. The Living Buddha had often sent him as an emissary to Peking, when misunderstandings or disturbances threatened the political peace of Mongolia. Very few of the important Mongols were not numbered among his friends, and the nomad dwellers on the plains knew him by reputation. To the foreigners over all China he is familiar as the principal dealer from whom race ponies are obtained, and there is little about the Mongol pony which Larsen does not know. Moreover, he is an enthusiastic sportsman. His knowledge of Mongol psychology and of the country was of much service to the Expedition.

THE ALLERGORHAI HORHAI

At the Cabinet meeting the Premier asked that I should capture for the Mongolian Government a specimen of the *Allergorhai horhai*. This is probably an entirely mythical animal, but it may have some little basis in fact, for every northern Mongol firmly believes in it and will give essentially the same description. It is said to be about two feet long, the body shaped like a sausage, and to have no head or legs; it is so poisonous that even to touch it means instant death. It is reported to live in the most arid, sandy regions of the western Gobi. What reptile can have furnished the basis for the description is a mystery!

I have never yet found a Mongol who was willing to admit that he had actually seen it himself, although dozens say they know men who have. Moreover, whenever we went to a region which was said to be a favorite habitat of the beast, the Mongols at that particular spot said that it could be found in abundance a few miles away. Were not the belief in its existence so firm and general, I would dismiss it as a myth. I report it here with the hope that future explorers of the Gobi may have better success than we had in running to earth the *Allergorhai horhai*.

A GOOD PLACE TO LEAVE

During the time that we were in Urga in May, 1922, conditions were most unsettled. It was the aftermath of the bloody days which had just preceded our coming, when Baron Ungern-Sternberg had slaughtered Jews and Bolsheviks by the hundreds.

After the Red Russians had occupied the country, a systematic clearing out of all Mongols opposed to their policies was begun. It was a reign of terror. No one knew how soon he would be accused of some crime and thrown into the horrible prison. One might even be there for months without knowing in what way he was supposed to have transgressed the law. The Minister of

War had been executed a few days before we arrived. The former Minister of the Interior, an old friend of mine, was under suspicion. I called upon him one afternoon. The next morning I went again on business and found his house in chaos. That night he had been dragged out and shot. It was not Mongols alone who suffered. Individuals of half a dozen nationalities, including Americans, were in difficulties. Murder and sudden death stalked ahead upon the streets. It was an exceedingly good place to leave.

It was also sickening to see the last remnants of medieval state ruthlessly destroyed in a country which was normally happy under the rule of its hereditary princes and a "people's reign" of terror and unhappiness substituted in its stead. It was like destroying a beautiful painting by an old master—a painting in which the colors have been only softened and enriched by time—and putting in its place a glaring chromo!

CHAPTER VII

URGA TO TSETSENWANG

LEAVING URGA

On May 10, I sent one of Mr. Larsen's Mongols to Tuerin to guide our cars to Bolkuk Gol, nineteen miles from Urga, where we were to join them. He went in a motor driven by a German mechanic, with two Chinese passengers. A friend of mine, Mr. Brandhauer, drove another car in which my wife and Doctor Black rode. The German's motor was rolling along peacefully on the great plain thirty miles from Tuerin when a wheel broke and the car capsized. One of the Chinese passengers was killed and the Mongol guide sustained a broken collar-bone and a fractured skull. Nevertheless, the plucky old fellow insisted upon fulfilling his duty of guiding our caravan to the rendezvous.

The Mongols at the telegraph station would not allow the dead Chinese to remain in the place. Doctor Black at last decided to bury him some distance away. The relatives of the deceased caused Brandhauer an enormous amount of trouble. Eventually he had to bring up a coffin from Kalgan, exhume the body and return it to China, besides paying a heavy indemnity. Spare parts were taken from our caravan at Tuerin and the broken car was repaired so that it could return to Urga.

At this time we heard rumors that the expected clash in China between Chang Tso-lin and Wu Pei-fu had taken place and that Chang had been defeated. The fact that there was no communication by telegraph and no mail service to Urga made it very difficult to obtain accurate news. We were all hopeful that Wu had been victorious, for at that time we foolishly thought that he might bring comparative peace to China.

On May 18, we left Urga with Larsen and Badmajapoff, after paying a final call on the Premier to say "goodbye." He was a high lama, an old friend of Larsen's, and had stoutly supported our cause in the official councils. When I thanked him he said: "Yes, it has been difficult. Things are not as they used to be a few years ago."

RENDEZVOUS AT BOLKUK GOL

We drove over the bridge across the Tola, just below the Living Buddha's palace, and up the hill to the beautiful meadow which sweeps from the base of

the Bogdo Ola down to the willow-bordered margin of the river. Marmots were popping in and out of their holes, whistling cheerily, and larks flooded the air with song. We were all very happy, for months of work in a new country lay before us and the political barriers had all been lifted.

The air was cold even in the sun. Two days before there had been a freezing wind and the summits of the Bogdo Ola glistened with snow; white patches covered the grass even on the lower slopes.

Motor trouble delayed us five miles from Urga. I could not diagnose it correctly, and Mr. K. P. Albertson, who had accompanied us to see the Expedition start, went ahead to bring assistance. In less than half an hour he returned with Colgate, Granger, Berkey and Morris. They had been on a geological trip along the river and Albertson met them only a few miles away. Colgate soon had the motor working and in the meantime we kept up a rapid-fire conversation. I got the first verbal reports of the great discoveries made in the vicinity of Iren Dabasu, and gave them an account of my own diplomatic experiences.

As we proceeded to camp, we drove up and down grassy hills. At Bolkuk Gol the blue tents were pitched on a gentle slope with a great snowbank glistening in the distance. The men of our Expedition had had a cold time of it, since they had arrived just in time to meet a real blizzard, even though it was mid-May. Two hours after we reached camp, Merin galloped in on his great white camel. The caravan was close behind him. Soon we saw the long line of camels silhouetted on the summit of a hill, with the American flag streaming above the leader. Thus for the first time the entire Expedition was together.

I worked until after dark selecting food, gas and other equipment to take with us in the cars, for we estimated that it would be nearly a fortnight before we would have contact with the camels again. Our destination was the province of Sain Noin Khan, about three hundred miles southwest of Urga. From Mongol reports, I judged it would be a fruitful field for our work. It was a leap in the dark, but if the country did not give us results we could always turn southward into the Gobi. Sending the caravan to that region would put it in a central position. Since it would follow our trail we could always send back to it for additional supplies or to give Merin further instructions, if necessary.

TOLA VALLEY

When we left Bolkuk Gol on May 19, 1922, we followed the valley of the Tola River west by south. I had traversed this same trail in 1919, and at the end of six hours' run we camped at the identical spot where my tents had been pitched after eight days of laborious cart travel. It was a beautiful valley. Wide flat meadows luxuriant with grass bordered the river and we were seldom

beyond a sight of a yurt or of herds of fat-tailed sheep, cattle and ponies. I did not try to do any zoölogical collecting, for my 1919 work had shown that the valley had been virtually denuded of animal life by the Mongols. We did not see even a marmot or a hare, and not a sign of antelope.

Geologically the valley consists largely of ancient graywacke rocks with interbedded shale or slate in some places. Our geologists designated this the Khangai Graywacke Series and found that it forms the major part of the mountains of the Arctic Divide, as well as the Khangai mountain range, through the province of Sain Noin Khan.

Our first camp was at the point where the Tola River comes down from the northeast and makes a sharp bend westward. On the northern bank stands a large temple, but we did not cross the river to inspect it, as we had no horses. Dozens of lamas, however, came over to us and examined our cars with the greatest curiosity and fear. They circled doubtfully about the tents and it was not until they realized that the strange things were temporarily harmless that they came in for a closer view. Then a blast of the horn or a sudden starting of the engine would send them scurrying in all directions with frightened shrieks. They told us that these were the first automobiles they had ever seen.

EYE-STRAIN IN THE DESERT

I had contracted a severe infection in my eyes while in Urga, and the glare and wind gave me such excruciating pain that I was happy when darkness came. As a matter of fact my eyes never recovered from the severe strain and it means the wearing of glasses for the rest of my life. The Mongols suffer from desert blindness, and eye-trouble is perhaps their most common affliction. To soften the glare they often use pieces of wood with narrow longitudinal slits; sometimes they weave "glasses" of black horsehair, or blacken the face about the eyes with soot. In later years I found that the Crookes lenses were by far the most satisfactory for desert use, but the damage had already been done so far as I was concerned.

"NIGGER HEADS"

After leaving the Tola River we turned directly southward and struggled through ten miles of what we called "nigger heads." The geologists, however, more properly termed them playa tufts. They are rounded mounds, which have been formed in sandy country by wind about the base of desert vegetation or some other obstruction. They vary from one foot to six or eight feet in height and usually are held together by the roots of low thorny bushes. In a low damp region the "nigger heads" are small, rounded, grass-covered hummocks such as are common in the marshes of America. From a distance

they give the terrain the appearance of the greatly magnified pebbled surface of a golf ball. Although their mode of origin differed according to the particular region in which they occurred, the trouble they gave our cars was a constant factor. There was seldom a day's run in which we did not encounter a few miles of this distressing terrain and in a single day we have crossed as much as fifty miles of it. In the fields of very high "nigger heads," we could always find a way through them by constant twisting and turning, but we had to go over the smaller ones, which were usually close together. This necessitated careful driving, and the strain on the chassis of the heavily loaded cars was enormous; nevertheless, we never had any breakage from this sort of terrain. A car with a rigid chassis simply could not go over such country. As soon as possible after such an experience, all the cars were given a thorough inspection and the bolts and nuts tightened; it was only by such care that accidents were avoided.

FIVE ANTELOPE CAMP

After leaving the field of "nigger heads," we came to a low mountain chain of granite much like that at Tuerin; for some distance intrusive granites in the form of great dikes and bosses stood out prominently among the rounded grass-covered hills. The geologists felt certain that we were traveling over pre-Cambrian rocks, but the relationships were so obscure that they needed some time in which to study the region; therefore they asked that we camp at a well twenty-five miles from the Tola River. I was not loath to stop, for it was a beautiful place and I was glad to continue my mammal collecting line from the spot where I had ended at the bend of the Tola River in 1919. It was so early in the spring that the grass was still short and no Mongols had come in to take advantage of what would be wonderful grazing later in the year.

We camped early in the afternoon in a great amphitheater formed by rounded hills. Not far away was a well of delicious cold water. We had seen one wolf and thousands of antelope, *Procapra gutturosa*, in the wide valleys, and marmots were whistling and popping in and out of their holes as though manipulated by strings. Granger and I, with the taxidermists, set a line of one hundred and fifty traps and looked forward to a new small mammalian fauna in the morning.

Badmajapoff, Larsen and Colgate hunted antelope and brought in five after a two-hour run. We christened the spot "Five Antelope Camp." Granger and I had a most interesting and profitable competition as to who could catch the greatest number of species of small mammals in a given number of traps.

All of us had a busy time at this camp. The geologists were out from daylight until dark driving over the surrounding country in their car. Even though the rocks appeared to be pre-Cambrian and unfossiliferous, still they

must work out the structure of the region and its relationship to that which they had already crossed.

FAUNA AT FIVE ANTELOPE CAMP

Badmajapoff shot a magnificent eagle owl, *Bubo bubo kiantschensis*, among the rocks at Five Antelope Camp. A few miles farther on, Larsen shot one that was sitting on its nest in a tiny cave in the precipice. He reported that there were three downy young and I went up immediately to photograph the nest and collect the young and materials for a museum group. When only a short distance from the spot we saw a large dark hawk fly off with a young owl in its claws. One baby remained, the other two having been taken in the hour which had elapsed since the mother was shot. The nest was in a niche in the rock, four feet high, two feet wide and two feet deep. It was unlined but contained many feathers of birds, small bones and pellets. The pellets were cylindrical and four inches long by two inches thick. In them I identified a great number of *Allactaga* bones, a few *Ochotona* and *Mus* and a musteline of some sort.

While we were at the nest, and for a long time afterward, the male owl soared like an aëroplane above the rocks. For two hours I tried unsuccessfully to get a shot. When we went to bed at eleven o'clock the owl called for an hour from the rocks; the note was a low, resonant *who, who, who.*

There were a few spermophiles living in a small colony, but strangely enough these animals were nowhere abundant until we reached Sain Noin. The gophers seem to have a peculiar distribution in Mongolia. Often we would cross hundreds of miles where there was not a sign of the animals; then suddenly we would discover a small isolated colony. This might consist of a very few individuals or even of thousands, as in southern Mongolia and at Sain Noin. Usually the colonies were not separated by any geographical or floral barrier, so far as we could perceive.

We caught a beautiful little hamster with a median dorsal stripe, which I identified as *Cricetiscus campbelli;* I had first become acquainted with it at Urga in 1919. A grassland vole, *Microtus brandti*, was very abundant and we caught our first picas, *Ochotona dauurica.* Shackelford waged war upon the marmots with a .22 caliber rifle and with steel traps. Marmot skins are one of the principal exports of Mongolia and millions are sent out every year.

MARMOTS

In 1921 I wrote a description of the Mongol methods of hunting marmots, which is as follows:

"The marmots hibernate during the winter, and retire to their burrows early in October, not to emerge until April. When they first come out in the

spring their fur is bright yellow, and the animals contrast beautifully with the green grass. After the middle of June the yellow fur begins to slip off in patches, leaving exposed the new coat, which is exceedingly short and is mouse-gray in color. Then, of course, the skins are useless for commercial purposes. As the summer progresses the fur grows longer until by September first it has formed a long, soft coat of rich gray-brown which is of considerable economic value. . . .

"The natives always shoot the animals. When a Mongol has driven one into its burrow, he lies quietly beside the hole waiting for the marmot to appear. It may be twenty minutes or even an hour, but Oriental patience takes little note of time. Finally a yellow head emerges and a pair of shining eyes glance quickly about in every direction. Of course, they see the Mongol but he looks only like a mound of earth, and the marmot raises itself a few inches higher. The hunter lies as motionless as a log of wood until the animal is well out of its burrow—then he shoots.

"The Mongols take advantage of the marmot's curiosity in an amusing and even more effective way. With a dog-skin tied to his saddle the native rides over the plain until he reaches a marmot colony. He hobbles his pony at a distance of three or four hundred yards, gets down on his hands and knees, and throws the dog-skin over his shoulders. He crawls slowly toward the nearest animal, now and then stopping to bark and shake his head. In an instant, the marmot is all attention. He jumps up and down whistling and barking, but never venturing far from the opening of his burrow.

"As the pseudo-dog advances there seems imminent danger that the fat little body will explode from curiosity and excitement. But suddenly the 'dog' collapses strangely and the marmot rises on the very tips of his toes to see what it is all about. Then there is a roar, a flash of fire and another skin is added to the millions which have already been sent to the seacoast from Outer Mongolia.

"Mr. Mamen often spoke of an extraordinary dance which he had seen the marmots perform, and when Mr. and Mrs. MacCallie returned to Kalgan they saw it also. Mac said that two marmots stood erect on their hind legs, grasping each other with their front paws, and danced slowly about exactly as though they were waltzing. He agreed with Mamen that it was the most extraordinary and amusing thing he had ever seen an animal do. I can well believe it, for the marmots have many curious habits which would repay close study. The dance could hardly be a mating performance since McKenzie Young saw it in late May and by that time the young had already been born."[1]

[1] Andrews, Roy Chapman. 1921. "Across Mongolian Plains." D. Appleton & Co., New York. Pp. 101–104.

Mr. J. H. Miller has given an interesting account of marmot hunting by the Mongols and Kirghiz of the western Altai Mountains. He says:

"As the old man and I rode along over the springy turf, the shrill whistle of the marmots resounded on every hand. By the autumn these jolly little animals have amassed such quantities of fat, preparatory to their winter sleep, that they present a most comical appearance. Their short legs are almost invisible, and, as they make for their holes, they look just like large muffs rolling down the hillside. Though these animals, along with the snow-cock, add greatly to the picturesqueness of the scene, they are no friends of the hunter. On several occasions, whilst after sheep or ibex, my stalk has been spoilt either by the whistle of the marmot, whose quickness of eyesight is almost unequalled, or by the weird cries of a covey of snow-cock as they sailed out over the valley.

"During the morning we came across a marmot hunter, a wild-looking figure clad in tattered sheepskins, and armed with an ancient long-barreled muzzle-loader, with the usual forked rest. During the summer these hunters wander about the hills, carrying nothing in the way of food except a goat-skin sack of 'kumiss' and a small bag of salt, tied to their saddles. They rely almost entirely on marmot flesh for their meat, only occasionally killing a wild sheep, when an easy opportunity presents itself.

"There are two methods of hunting the marmot adopted by these people: one is merely to make a low breastwork of sods within thirty yards or so of a well-used burrow, and lie patiently behind it till a beast appears; the other requires slightly greater skill and energy. On locating the marmot outside his hole the hunter advances boldly towards it at a rapid walk, carrying his gun in his right hand, and incessantly waving a bunch of white sheep's wool attached to a stick, or a fox's brush, in his left. This unusual sight so excites the curiosity of the marmot that he will often sit bolt upright at the entrance to his hole and allow the hunter to approach close enough for a hurried shot."[1]

Marmots give birth to from two to four young each season. By mid-June the babies are about ten inches long and covered with soft yellow-white fur. The little fellows are very playful, and I have often seen them rolling about like kittens in the grass near their burrows, while one or both of the parents keep watch. By August 15, the young are two-thirds grown and have assumed the brown winter pelage.

The large weasel, *Mustela larvata tiarata*, is a very real enemy of the marmot, and I have frequently caught these fiery little beasts in traps set in marmot holes. In August, 1918, some disease took a heavy toll of marmots in the Urga region. I saw many lying dead beside the road and others that were

[1] Carruthers, Douglas. 1914. "Unknown Mongolia," with three chapters on sport, by J. H. Miller. Hutchinson & Co., London. I, pp. XVIII, 1–318; II, pp. X, 319–659.

barely able to crawl to their burrows. This was most significant, since, from January to April of that year, pneumonic plague had been raging in southern Mongolia, Suiyuan, Chahar, Shansi, Chihli, Shantung, Anhwei and Kiangsu. Sixteen thousand victims had been claimed by the disease. It has been suspected that marmots had a very direct relation to the series of outbreaks of pneumonic plague in southern Siberia, Mongolia, and Manchuria.

Dr. Wu Lien-teh, Director of the Manchurian Plague Prevention Service, conducted researches in Mongolia during 1912 and concluded the pneumonic plague epidemics arise as a secondary manifestation of bubonic plague, but that the pulmonary form of the disease was not directly communicated to man by marmots. In other words, that the Manchurian epidemics arose as a result of primary bubonic infection invading the lungs in addition to other organs. He found that chronic plague may exist among marmots, giving rise to epidemics of bubonic plague as a direct result of infection from skinning or eating the flesh. He could not be sure whether the rat or the marmot was most important in distributing the bubonic disease in Manchuria. His experiments showed, however, that marmots are easily susceptible to the pneumonic form produced by their inhaling the *Bacillus pestis*. He found that the mask was the principal means of personal protection against pneumonic plague.

In Manchuria and Mongolia where he worked along the line of the Chinese Eastern Railway, Doctor Wu said that both the Siberian and Mongol settlers eat the flesh of marmots and that considerable quantities are salted and exported to European Russia. He himself ate the flesh and found it to be tender and to compare favorably with rabbit meat. I never saw the Mongols eat marmot, but probably that was because other and better meat was easily obtainable.

Doctor Wu reported that the Chinese and Russian hunters along the railway snare the marmot by arranging a wire loop over the hole. In the parts of Mongolia that I have visited the natives knew nothing of this method of trapping. He also remarks that the Mongols will not touch a sick marmot or one that seems unable to escape when surprised, and that consequently plague is but seldom reported among the Mongols. On the other hand, the Russian and Chinese hunters handle even sick animals carelessly.

Most marmot burrows have two or more entrances. The earth that has been dug forms a flat-topped mound covered with grass which usually is somewhat greener than that of the surrounding plain. Thus, with a little practice one can distinguish the dangerous holes a considerable distance away. After leaving the northern grasslands and turning southward into the desert, we saw no more marmots until we reached the Altai Mountains. There on the grassy slopes at seven or eight thousand feet above sea-level the animals were again abundant.

ARGUL AND CAMP COOKERY

May 21 was the first time that we were able to sit comfortably in the tent without the warmth from an "argul" fire. "Argul" is the Mongol name for animal droppings, which furnish the only fuel on the plains and deserts. It corresponds to the term "buffalo chips" of our American west. Argul makes a hot fire which soon burns out and must have a draught to keep it blazing. When we made camp it was the duty of our three Mongol interpreters to collect argul for the camp as soon as the tents were up. The cooks usually carried a supply with them so that dinner was not delayed. The Mongols have become so accustomed to using argul that even when they are camped on the edge of a forest, they prefer to collect it rather than bring in wood. Their "stove" consists of a small skeleton cylinder made of strips of iron and open at the top and bottom. Three-inch spaces between the iron hoops allow for a sufficient draught.

Our cooks used an oven which I had developed out of a Standard Oil tin. A cover at the end was hinged by bits of wire so it could be dropped down and fastened; with other pieces of wire, flanges were made, longitudinally, which served as rests for the trays. One of the great advantages of this oven lay in the fact that when one was worn out another could be constructed in an hour, for we always had a sufficiency of gasoline tins. The cook would dig a narrow trough directed toward the wind. Then with the oven rested across this trench on iron tent pegs, an argul fire was built below and on top of the oven. Biscuits, bread, meat and even pies and cakes could be baked in this simple oven as well as in a kitchen range.

SOUTHWESTWARD TOWARD TSETSENWANG

On May 23, we left Five Antelope Camp for the monastery of a Mongol prince, Tse Tsen, on the way to Sain Noin. Our trail continued southwestward, among grass-covered hills where great granite bosses stood out like ramparts against the sky. It was a beautiful grazing country. In the bottoms of several valleys streams of sweet clear water ran between banks of emerald-green grass. But as yet the Mongols had not moved their yurts and the country was deserted save for antelope and birds.

SNAKES

Beside the trail we found a brown pit-viper, *Agkistrodon halys intermedius*, the only species of poisonous snake that I saw in Mongolia. It is about two feet long with a thick body and dull brown color. It is related to our American copperhead. Because of the long, bitterly cold winters and excessive dryness, the reptilian fauna of Mongolia is exceedingly limited. We caught only one other snake in the desert, the non-poisonous *Elaphe dione*, from the edge of

PLATE XVII.

A. A PET RED-BILLED CHOUGH TELLS THE CHIEF PALÆONTOLOGIST A SECRET.

B. BRANDING MONGOL PONIES IN MR. LARSEN'S COMPOUND AT URGA, 1922.

PLATE XVIII.

MONGOLS LISTENING TO A PHONOGRAPH.

Usually they were greatly frightened when hearing it for the first time.

the grasslands which range into Chihli and Shansi Provinces of China. The viper appears to have adapted itself exceptionally well to the long periods of hibernation and starvation, for in certain places along the face of gravel bluffs it was present in numbers. In fact we had several most uncomfortable experiences with them in later years.

The Mongols are afraid of these vipers, and the sight of one in the road threw our interpreters into a panic. That night they refused to sleep upon the ground and betook themselves to the cars. I found that the Mongols have the same method of protecting themselves from snakes that is used in the American west. They stretch a camel's hair rope around the camp on the ground and believe that the vipers will not crawl over it. This is only one of the many similarities in life and customs, which like conditions have developed between the Mongols and our own westerners.

MONASTERY OF TSETSENWANG

We had become so accustomed to the deserted hills that it was most surprising to suddenly top a long slope and see below us in a wide valley the lama monastery of Tsetsenwang. It lay like a miniature city of tiny houses, temples and pinnacled shrines, walled in by enormous piles of argul. The monastery was similar to the one I have described at Tuerin, but was considerably larger.

To the north we could see the gaping mouths of three canyons, and before the lamas had time to give more than a yell of surprise the whole fleet of cars had passed on up the valley. I selected a camping ground well up in one of the canyons where we were partially sheltered from the wind. A tiny stream gurgled over a bed of white stones and in the next canyon to the north an ice floe spread out like a vast white fan; it would be many weeks before the miniature glacier melted.

THE GREAT MONGOLIAN BATHYLITH

Ever since leaving the Tola River and turning southwestward, we had traveled over a floor of ancient rocks, in which graywacke predominated. The great intrusions of granite in the form of dikes had become more and more frequent as we neared Tsetsenwang. It was a region that required study by the geologists, and as I wished to wait here until the camels arrived we made ourselves snug for at least a week.

Berkey and Morris spent most of their time driving about the surrounding country in their car and covered several hundred miles during our stay. They had begun to realize that the great granite masses which we had encountered ever since leaving Kalgan were definitely connected and that they were about to make a most important geological discovery. Regarding it they have

written as follows: "The Third Asiatic Expedition, in the early stages of its traverse across Mongolia, repeatedly noted occurrences of granite. Some are small intrusives, whereas others cover extensive areas of undetermined boundaries. They are associated with so great a variety of other rock formations of widely different ages, that at first there was little to suggest their possible unity. Because of the fact also that the granites themselves show considerable variety of minor character, it was assumed that they were essentially independent intrusion phenomena that might have as great age differences as the hosts with which they are associated.

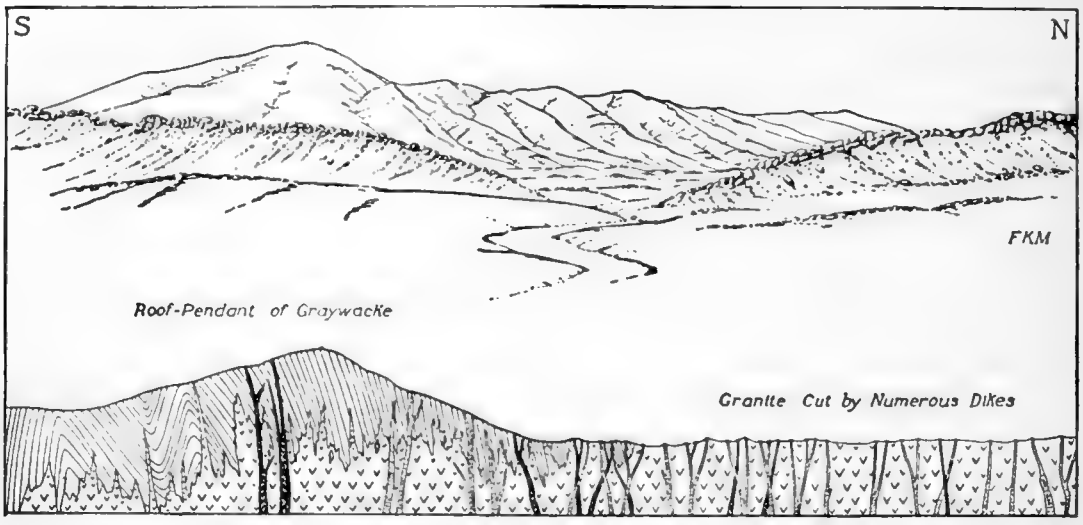


FIGURE 8.—Margin of a roof-pendant north of Tsetsenwang. From "Geology of Mongolia."

"As the traverse was extended northward from Kalgan, however, a certain similarity of rock type and of field relation was noted, suggestive of a possible common origin. This became all the more impressive in the north and west, where, in many places, the rock floor for tens of miles together is made up wholly of granite.

"It is the purpose of this paper to indicate some of the evidence bearing on the structural and genetic relations of these granites, and to support, in more definite terms than has hitherto been done in the publications of the Expedition, the conclusion that they represent a great granite bathylith."

The authors conclude: "For this bathylith, which in dimensions seems to compare favorably with the greatest bathyliths thus far known in other parts of the world, we propose the name 'The Great Mongolian Bathylith.'"[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1924. "The Great Bathylith of Central Mongolia," *Amer. Mus. Novitates*, No. 119, pp. 1–11; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 24, pp. 1–11, 1926.

FAUNA NEAR TSETSENWANG

In the broad valley north of our camp there was a marshy region which developed into a series of salt lakes; the largest of these was at least a half-mile wide. Salt thickly encrusts the marsh and gives a white margin to the lake. Probably it is always too saline for fish, and the Mongols said that none were ever found there, but great numbers of waterfowl were resting on the surface. I identified swan-geese, mallards, teal, ruddy and burrow sheldrakes and a dozen great white swans, probably whoopers, *Cygnus cygnus*. Probably these birds were nesting in the vicinity. In fact, the canyon resounded all day with the cries of ruddy sheldrakes, which were continually flying up and down the stream and gabbling among the rocks.

There were many red-billed choughs, *Pyrrhocorax pyrrhocorax*, among the rocks of our canyon, and "Buckshot," one of the Chinese assistants, brought four young to camp. He fed them on fresh meat soaked in water. Subsequently they became our most amusing pets, being as tame as chickens and flying all about the tents. They were intensely curious. I have a photograph of one sitting on Granger's head while investigating his ear; a few moments later it even put its bill into the bowl of the pipe he was smoking.

At night we heard the howling of wolves from up the canyon. Larsen found a den which showed signs of containing young. We set traps in the two entrances while the she-wolf sat on a crag overlooking the scene, howling dismally. She was so suspicious that she did not return for two days. At last we dug into the den and obtained two pups as specimens; they were about the size of half-grown cats. The Mongols said that occasionally lynxes were seen among the rocks, but we found no signs of them. In the forest, north of Urga, I shot a beautiful lynx, *Lynx lynx isabellina*, but I believe that its southern range is where the coniferous forest meets the plains, and that this species, at least, would not be found on bare hills.

On the flat ground at the entrance to the canyon there was a vast colony of meadow voles, *Microtus brandti*. I have never seen so many individuals of a single species of any mammal. To say hundreds of thousands is not overstating their number. The plain was literally alive with them and one could not step without treading on their burrows, which were connected by tiny paths. A continual high-pitched chirping sounded like thousands of crickets underground. They appeared to be almost entirely diurnal, for our traps caught many more during the day than at night and we saw them at all hours. Granger and I caught a dozen young of varying ages in our hands.

All other small mammals were very rare at this camp; even such usually abundant species as hamsters and jerboas were almost non-existent. It is, I believe, quite certain that the *Microtus* were responsible for this condition, for their great numbers had made it difficult for other small mammals to live

there. We first encountered this species at Five Antelope Camp and it carried on to the southwestward continuously to Sain Noin, which was as far west as we went in the grasslands. It was always abundant except where there was a gravel terrain; evidently it is a true grassland vole.

PRINCE TSETSEN

Tse Tsen Wang was one of the richest and most powerful of the Mongol princes in 1922. He was then about fifty years old, nearly six feet tall and beautifully proportioned. The blood of a long line of high-born nobles runs in his veins and shows in his finely cut features. His younger brother, who was in Urga, was a handsome man and fulfilled all the romantic western ideas of how an Oriental prince should look. He was most careful in his dress, wearing long gowns of richly brocaded silk, gorgeous sashes and hats of gold thread or sable. He was a good deal of a "young-man-about town," a fine shot and a splendid horseman. He seldom went on the street without one or two retainers, who likewise were carefully dressed and wore peacock plumes in their hats. All the hereditary nobles of Mongolia whom I met could easily be distinguished, by their finer features, from the ordinary natives. Some of them still maintain considerable state and rigidly adhere to certain forms of intercourse with strangers.

The ruling prince was a fine type of Mongol aristocrat. I had met both him and his younger brother in Urga and had purchased several ponies from them. In 1919, he had a herd of ten thousand ponies and many sheep and camels. In 1920 the Chinese soldiers confiscated twenty-four hundred ponies, and the new régime of Russian-Buriat control in Urga had treated him almost as severely. He still had a good many sheep and camels but was fearful of what would happen to them in the next few months. On the day after our arrival, Larsen, Badmajapoff and several others drove over to call on the prince. At that time his yurt was about ten miles beyond the monastery, but he shifts it frequently as the feed changes. They reported that he lived in considerable state and comparative cleanliness.

CHEESE AND KUMISS

The next day Tse Tsen Wang returned the call and spent the day in camp. He brought a great chunk of white cheese and a skin bag of "kumiss." The latter, made of fermented mare's milk, is the national drink of the Mongols. It has rather a sour, not unpleasant, taste and is highly intoxicating. "Kumiss" may be found in the yurt of almost every Mongol, and it is not infrequent to meet men suffering from its effect, but I do not believe that, as a whole, the natives are intemperate. The Mongol cheese is very palatable but usually it is made in such an unclean way that I discouraged its use by our men.

The wooden pails in which the milk is drawn are never washed, and one can extract hair and even less desirable elements from the cheese. Nevertheless, I have often had to eat it in Mongolia when there was nothing else and found that it was most sustaining.

TRACES OF PRE-MONGOL PEOPLE

On the hill-slopes of the main valley and farther to the westward in the grasslands are many ancient remains of great archæological interest. They are of two kinds: one, a large circle of small stones with a low rock mound in the center; the other, a rectangular space enclosed by upright stone slabs. The natives could tell us nothing about these burial places except that they were "very old and had been made by people who lived long ago." Badmajapoff said that in the country to the west the Kozloff expedition had opened many similar graves which contained skeletons, together with gold and bronze objects.

In 1914, Douglas Carruthers, in his splendid book "Unknown Mongolia," discussed similar structures in the upper Yenisei basin. There he found monoliths, rock-pictures, tumuli or circular mounds, and rectangular graves. The two last appear to be somewhat like those we saw. He says that both types are burial spots, and in later years we opened several which contained skeletons and iron implements but no gold or bronze. Carruthers speaks of gigantic mounds surrounded by upright stone slabs which he believes were tribal meeting places, but we found nothing of the sort; neither were monoliths present in the region we visited, except in one instance.

It is impossible to tell from the present available data who made the graves which we found in Mongolia. Carruthers believes that those in the Yenisei basin probably were the work of the Uigurs. He remarks:

"About the third century B. C. there emerged into prominence a people who were destined to leave their mark on the whole civilized world. Somewhere from the far south of Mongolia, perhaps from the borders of China—from the present-day provinces of Shensi and Kansu—came a wandering people, the Uigurs. The origin of the Uigurs is problematic, but as far back as this it can be traced with fair certainty. These tribes wandered northwards, and eventually settled in Mongolia. Here they increased and flourished, and eventually spread over the Yenisei regions as far north as the Chulin River, until, in the eighth century A. D., their kingdom reached over the whole of Northern Mongolia from Lake Kossogol to the Black Irtish. . . . In the ancient Uigurs we have the origin of the Turkish race who later on overflowed all Central Asia and made an empire on the shores of the Bosphorus."[1]

[1] Carruthers, Douglas. 1914. "Unknown Mongolia," with three chapters on sport, by J. H. Miller. Hutchinson & Co., London. I, p. 51.

We found graves, of a generally similar type to those at Tsetsenwang, from the frontier of China northward right across Mongolia. Those in the northern grasslands were much more numerous and better constructed than those in the south and central Gobi. It is probable that they are of widely varying age and were made by people of different tribes or races, but all pre-Mongol.

Berkey and Morris discovered, between two lakes north of our camp at Tsetsenwang, a well-preserved and very ancient dam, half a mile long and fifteen feet high; also the foundations of a stone structure of several rooms. Some months later, near Tsagan Nor, in the Gobi, we found a similar dam and remains of what appeared to be irrigation ditches. These were evidently pre-Mongol and must have been constructed by a people who practiced agriculture.

In the Yenisei basin, Carruthers mentions ancient irrigation canals and says that present settlers have actually opened some of them for their own use and found that their engineering was in no way at fault. Thus it seems evident that western and northern Mongolia, and probably the entire country, was inhabited by a well-developed race, or races, long before Mongol time.

Near one of the graves at Tsetsenwang, Shackelford picked up two pieces of rock, one of which contained flecks of garnet and the other gold; the latter would run about one hundred dollars to the ton, Doctor Berkey estimated. We made a careful search for the masses from which the fragments originated but were not able to discover them. Doctor Berkey believed that they must have been carried there from some distance.

JURASSIC PLANT FOSSILS

The geologists found a low mountain of Jurassic sediments not far from camp. It contained abundant plant remains but no vertebrate fossils. On May 29, they drove fifty miles to the south and reported a further great area of Jurassic rock twenty miles across, and beyond it an arid desert.

CARAVAN PLANS

The caravan had arrived May 28, 1922, with several of the camels pretty well exhausted. Since we had been in a grassland country and camels cannot thrive on grass, they had been on very short rations. I took enough gas and food into the cars to let the weak camels follow without loads, and started the caravan for Sain Noin, one hundred and fifty miles away, with orders to travel slowly and feed on the way.

CHAPTER VIII

SAIN NOIN AND THE HOT SPRINGS OF ARISHAN

SOUTHWESTWARD FROM TSETSENWANG

We were all glad to leave Camp Tsetsenwang on May 30. It had been an interesting camp for the geologists from the standpoint of continental structure, but it was rather unproductive for the rest of us. I was keen to discover more fossiliferous sedimentary basins, but it was evident that the general direction of the strata lay east and west and that we were traveling parallel to it. If we were to get away from the hard rocks we must turn sharply southward into the desert.

The trail southwestward to Sain Noin led up and down a series of grassy hills where some of the grades were so steep that it seemed impossible for the motors with their heavy loads to negotiate them. Nevertheless, we went up without difficulty and once more congratulated ourselves upon having selected the Dodge Brothers cars. Three bad stretches of dry marshland covered with "nigger heads" gave us an unwelcome change from the hills; then we came into a long valley dotted with lakelets and white with herds of sheep and goats. Perhaps a dozen yurts were tucked up against the hill-slope. It made a very pretty picture of Mongol life.

CANYON BROOK

When we were forty miles from Tsetsenwang we emerged from the hills on to an arid plain covered with sparse bunch grass growing on a gravelly soil of disintegrated granite. Off to the north lay a range of low rocky hills, cut by a deep canyon. We pitched the tents just at the entrance to a canyon, on the grassy bank of a clear stream. It was delightful to feel the soft grass under one's feet and to plunge into water so cold that it made one gasp. We named the camp "Canyon Brook." Our early stop was made at the request of the geologists. They had been worked well nigh to death, for the short run of forty miles had been across a complicated structure of ancient rocks much folded and crushed. It was impossible to determine the relationships accurately in a few hours' study. They did not arrive in camp until very late, and

the next day drove back over our trail to check their work and investigate the surrounding hills. In our canyon they found a considerable exposure of pre-Cambrian limestone.

From the camp we could see, with glasses, a temple and yurts about three miles south of the trail. We ran toward it but found our way barred by an enormous marsh. Swans and geese were floating on the surface of a lake in the center, and a great flock of golden plover, numbering at least a thousand, were feeding among the "nigger heads."

There were several small encampments of yurts along the edge of the marsh and we had a rather amusing time with the Mongols, who had never before seen a motor car. The mirror, horn and electric lights were the chief wonders, and we created enough topics for conversation to last them for months by finally persuading half a dozen to ride with us for a few hundred yards.

On the hill-slopes and plain to the east of the marsh there are many graves and mounds like those at Tsetsenwang. This must have been a populous region in pre-Mongol days, and very probably the valley had been used extensively for agriculture. In the summer of 1925, press reports stated that General P. K. Kozloff had made important archæological finds in this district, but I have no direct information concerning them.

FAUNA AT CANYON BROOK

The small mammals at this place were interesting. Among the rocks at the entrance to holes I saw little piles of banana-shaped droppings which I could not identify. I felt certain that I was about to discover a mammal, new, to me at least. The next morning my traps contained a rather large vole-like mouse, which has since been described as a new race by Dr. Glover M. Allen, 1924. He has given it the name *Microtus (Alticola) worthingtoni semicamus* and says that it "is undoubtedly a close relative of *Alticola worthingtoni* of the Tian Shan, nearly a thousand miles to the westward. . . . The fine series of this large gray microtine extends the known range of the subgenus northeastward into central Mongolia which may be near the limit of its distribution in this direction."

We found this mouse at several other camps to the westward, and could always determine its presence by the piles of banana-shaped dung. It is a true rock mouse and the soft fur and ears are suggestive of the picas or conies, *Ochotona*. Like them it has the habit of pulling stalks of grass and flowers into its burrow under the rocks. The animals are partly diurnal, for I saw them several times in the late afternoon. They are remarkably fearless and curious; often they would come within ten inches of my hand.

I trapped several conies, *Ochotona pallasi*, at this camp. The burrows

were easily identified by the characteristic spherical droppings scattered about and the masses of vegetation drawn into the holes. On the plain at the entrance to the canyon I saw signs of other conies among the stiff grass, and later caught the animals. It was rather a surprise to find that this species lives on the plains as well as in the rocks.

CARAVAN TRAILS

The next morning we followed the same faint trail on which we had traveled since leaving Tsetsenwang. It was about two feet wide and at times was hardly more than a shadow on the hills. Often we lost it altogether, yet this same trail has doubtless been in existence for centuries and runs through to Uliassutai.

It was amazing how much easier our traveling became if we could follow a trail, no matter how small. The great flat feet of a camel are natural road makers. They tramp down the sand and fracture the stones enough to leave them more easily acted upon by wind and frost and rain. Perhaps only one or two caravans may follow a trail during a season, or even several years may go by without the passing of a single camel, but still the trail exists. There were many occasions when it would have been impossible for us to cross a sandy area with our cars had we not discovered a caravan track.

A network of trails crosses Mongolia. The most important run from Kalgan, Kweihwating and Paotowchen on the Chinese frontier, north to Urga, and northwestward to Uliassutai and Kobdo. These have been in existence for hundreds or thousands of years. They are the trade routes which connect India, Russia and China; the routes which the great silk caravans followed, even before the days of Kublai Khan and Marco Polo. They are being followed to-day in the same way, but by camels carrying different products.

The great routes are marked by wells, sometimes ten miles apart, but often as much as fifty or sixty miles, depending upon the country and the depth of the water-level. From the "main lines," branch trails run in all directions. They may go a few miles to a temple or may end seemingly in "mid-air." Usually, when they have no apparent excuse for being, it means that at some time during the year the spot where they end is a favorite Mongol camping ground. When the use of motors becomes general, as must inevitably happen, and all the passable trails have been accurately plotted, the map of Mongolia will look like a spider's web.

The average Mongol knows comparatively little about the trails except those in his immediate vicinity. Each year he moves perhaps half a dozen times, but always in a certain region prescribed by his local prince or chief. He cannot go beyond the area that has been allotted him or he will infringe upon the grazing rights of others. He knows the trails within that region like

a book, but unless he has happened to make a journey to some far-distant place he can tell you little about other sections of the country.

The people from whom to obtain real information are the Chinese traders. Year after year they cross Mongolia, taking tea, cloth and tobacco to far-distant points in Central Asia and returning with wool, hides, furs and ponies. At present Mongols do but little caravan trading on their own account, but the Chinese merchants will often hire a few to assist with the camels.

We could always recognize a Chinese caravan at a distance because the Chinese invariably use camel bells, whereas the Mongols almost never do. Again, the Chinese caravans usually travel with the camels in single file in groups of twenty, each animal tied by its nose-rope to the load of the one in front of him; the Mongols often lead the caravan in a compact mass. The Chinese herders in charge of each group of camels usually walk; the Mongols always ride.

The picturesque caravan traffic in Central Asia will persist for many years even after the inevitable railroad has crossed the desert. There are many isolated regions, not rich or important enough for railroads ever to reach, from which the products are too bulky to be carried by motor car. Therefore, I believe that this transport of the Middle Ages will continue to exist to some extent even when the twentieth century has drawn to a close.

DESERT WEATHERING OF GRANITE

The first twenty-five miles westward from "Canyon Brook Camp" was what Morris called a "geological nightmare." We fervently echoed his sentiments from another standpoint, for it certainly was a "motorist's nightmare" as well. The tiny trail wound in and out among rocks and over ridges on some of the worst terrain we encountered in all Mongolia. The hills were covered with a chaos of jagged stones. In every direction masses of granite, like the vertebral columns of huge dinosaurs, cut the surface, and enormous boulders were heaped one upon the other as though they had been a giant's playthings. It was a dreary country. Only a faint shading of yellow-green vegetation relieved the monotony of dull brown. There were no yurts and we met only three Mongols. They were huddled under a wretched little tent beside the trail and gave the crowning touch to the picture of desolation. They were bound, they said, for a great lamasery far to the southward in the Altai Mountains.

THE ONGIN GOL

After leaving the rocks the trail took us into a dry marsh among "nigger heads," which only changed the character of the bad going. Just beyond the marsh our trials were ended. A series of rounded hills, and then a gravel

plain almost as smooth as a tennis court, descended very gradually to the Ongin Gol.

I had drawn a mental picture of a gently flowing river with grassy banks, shaded by willow trees. The reality was a disappointment. A shallow stream, split into three small branches which wander rather aimlessly through the gravel plain, is the Ongin Gol at this point. It flows southeastward from the Khangai mountain range, which forms the Arctic Divide farther to the north. Where we crossed it, the river occupies a valley several miles wide, within which is cut a still lower trench about a third of a mile in width. The stream occupies only a small part of the inner valley, though it is evident that the river has flowed in other channels in past times. Not a tree could be seen, but there was grass, and we camped on the west bank early in the afternoon.

The geologists had lagged far behind, and when they arrived their Chinese chauffeur drove recklessly into the widest branch, stuck fast between two rocks, jammed on full power, and promptly snapped the rear axle. It required hours of hard work with the block and tackle to get the car out and to replace the broken part.

THE STORY OF A MASSACRE

I was surprised that there were no yurts beside the river where the fresh grass offered such excellent feed. Our Mongols could not explain it, but when I sent Tserin over to a nearby ridge to shoot some sand-grouse for dinner, he came back with two wretched Mongols who related a sad tale.

Only a few months earlier there had been an encampment of seventeen yurts almost where our tents were pitched. It was a peaceful Mongol village numbering about fifty individuals. One day a Chinese caravan from Uliassutai, on the way to Kweihwating, laden with sable skins and other valuable furs, had camped beside them. During the night a party of Russians arrived and slaughtered every living soul, men, women and children. It was "*spurlos versunken*"; so far as they knew, not a human being was left alive to tell the tale. Then the Russians drove off the camels with their loads of furs, and all the Mongols' sheep and goats. Even the dogs were shot before they left.

The two Mongols who told us the story were away the night of the massacre and had arrived just in time to witness the destruction of their homes and families. From the shelter of the ridge they had watched it all, and since that time had lived half-crazed among the rocks, unable to tear themselves away from the bloody spot. Unfortunately, there was every reason to believe that the tale was true; it was only one of many similar events that marked the frightful winter of 1921. The things I had heard in Urga, of the "Bloody Baron" and his awful vengeance upon the Jews and Bolsheviks, recalled the worst days in the history of the inhuman "Ivan the Terrible."

RAINY GULCH CAMP

We awoke, on the morning of June 2, to a lowering sky and certain indications of rain. I knew that it was imperative to get the Expedition away at once, for two miles of not too dry swamp land lay between us and high ground; a few hours of rain would turn this into an impassable morass.

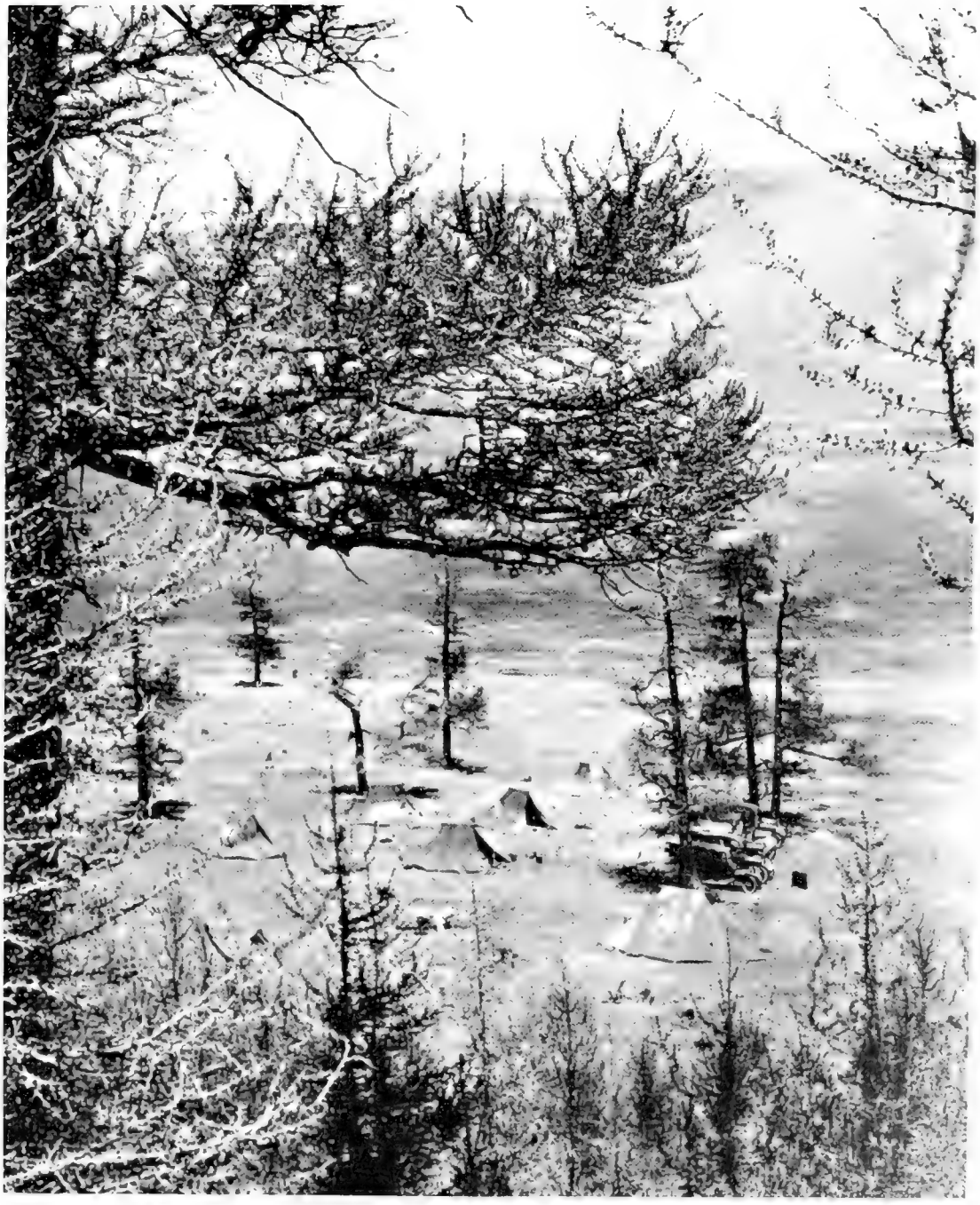
The car was repaired, and camp was broken at eleven o'clock. We negotiated the "nigger heads" successfully and, as usual in Mongolia after particularly bad terrain, we then found ten miles of level plain. Half a dozen herds of gazelles were feeding near the trail and I killed two for meat. The firing not only secured the animals but frightened nearly to death the inhabitants of two yurts, from whom we wished to obtain information concerning the trail. The men leaped upon their ponies and dashed for a rocky outcrop, leaving the women to their fate. As Shackelford pertinently remarked, the Mongol motto is "Save the men, to hell with the women and children." It took considerable quiet conversation by our Mongols to assure the poor women that we were friends and would not harm them. The slaughter at the Ongin Gol was fresh in their minds, and the sudden appearance of strange machines, the like of which they had never seen, combined with rifle shots, made them certain that a horrible death awaited them. Eventually they told us that the tiny trail we were following went to Uliassutai, and that we must cut across country northward to a big road which reached the Sain Noin monastery.

We had hardly gained the trail before a storm broke with terrific violence. We could only back the motors into the wind and keep as dry as possible. A deluge of rain and hail poured from a night-black sky lit by continuous lightning. The crash of thunder made it impossible to talk. The storm raged for half an hour, and when we saw the brown rivulets cut their way down the sparsely covered hillsides we began to appreciate the erosion effects of such torrential rains.

Fortunately we were only a short distance from Sain Noin, and pitched camp in the valley of the Tarmil Gol, a tributary stream which flows northward to the Ongin Gol. We called it "Rainy Gulch Camp." The valley was well populated, for Mongolia. Opposite camp a village of a dozen yurts lay on a hill-slope. We made friends with our neighbors at once, and in return for baskets of dry argul gave them cigarettes and empty gasoline tins. Bottles are such a desideratum that we kept them for very special favors.

Our camp at Rainy Gulch was at a higher elevation than any we had reached up to that time. The aneroid readings indicated more than six thousand feet. The mountains which we could see from camp form the divide between the drainage flowing toward the Arctic and that flowing southward into the desert.

PLATE XIX.



THE EXPEDITION CAMP IN THE FOREST NORTH OF SAIN NOIN KHAN, 1922.

PLATE XX.

THE TEMPLES AND LAMA CITY AT SAIN NOIN KHAN, 1922.

SAIN NOIN MONASTERY

The following day we drove to the monastery, five miles away. Because of its beautiful setting it is the most impressive of any that I have seen in Mongolia. The summit of a long grassy hill is crowned with an enormous and well-constructed obo. It consists of a circular base of stones, with a secondary tier and a conical center decorated with prayer flags, bits of cloth and branches. As this is a very sacred spot to the Mongols, Badmajapoff, who was with us, warned us not to approach too closely. Below the obo on the green plain, the golden spires and upturned gables of the temples glistened in rainbow colors. Just beyond the monastery the Ongin River has cut its way through a table of solid rock, and in the distance wave upon wave of snow-crowned mountains rise.

The temples are in the center of the "city," with the tiny wooden houses of the lamas spread out on each side like great wings. A palisade of unpeeled logs surrounds the entire monastery, and most interior compounds have their own enclosures. The temples are interesting and show three distinct types of architecture. The first has the squat rectangular Tibetan base, but the upper half is a typically Chinese, pagoda-like structure. Behind it stands a temple of pure Tibetan construction, square, massive and flat-topped. Enormous troughs of weathered wood, like rain spouts, extend out at intervals from near the roof. The walls are white, bordered by black with red bands; the corner decorations are of gold leaf. A third temple is of Chinese architecture throughout, roofed with green glazed tiles. There are ten temples in the monastery. The usual whitewashed shrines and prayer wheels are particularly numerous; the central shrine has the lower part plated with sheets of tin from Standard Oil cans, and the upper half covered with pure gold leaf.

The Khan's winter palace is in the northeast corner of the lama city, and with his private temple is surrounded by high palisades. The Khan was then only ten years old, and his uncle, a high lama, was acting as regent. Later we visited the regent at the Hot Springs.

We called upon various officials at the monastery, after Badmajapoff had visited them, to explain our objects, and were most cordially received. There was much more order and discipline among the lamas in this monastery than in any other which we visited in Mongolia; moreover, the lamas themselves and the surroundings are exceptionally clean.

GEOLOGY OF THE SAIN NOIN AREA

Although we had no hope of finding fossiliferous sedimentary basins in this region, we were obliged to wait until the camels arrived; nevertheless, there was much of interest for all the members of the Expedition. The geologists, especially, were busy from sunrise until late at night, investigating the

complex rock structure of the valley. They found that for a long distance the graywacke series, which is much folded, jointed and crushed, forms the hills and mountains to the northeast of the monastery as well as the more distant higher mountains. Indeed, it is the dominant formation of the Khangai Range. In the vicinity of the lamasery there are several miles of basaltic flows, which have been poured out into the bottom of an older valley by late volcanic action. Since that time erosion has continued and the stream is again channeling its way through the volcanic material.

YAKS

On the northern slopes of the mountains, just beyond the lamasery, were patches of larch trees, and I decided to move camp sixteen miles to the north so that we might have an opportunity to study the forest conditions. A day of prospecting to locate a suitable spot took us across the Ongin River and up a long valley north of the monastery. As we were about to cross the stream, a great herd of yaks, driven by Mongols, came down the opposite bank. They were the first yaks any of the men, except myself, had ever seen. Each one was trailing a log on either side, and the great shaggy brutes, with their enormous tails and the long belly-hair reaching to the ground, made a splendid picture as they dashed into the water. They were very wild, snorting and grunting whenever they came near us, and the Mongols had a lively time to handle them.

Most of the animals were pure-blooded yaks, but a few showed by their lighter build, shorter hair and smaller tails that they were "yak-cows"—a cross breed between yaks and the Mongol cattle. This cross appears to make very good work animals and I have seen many drawing carts in Urga. They are not so wild and difficult to handle as are the pure-blooded yaks. Yaks are used extensively in the forest region of northern Mongolia, and even as far south as the eastern Altai Mountains. We found a few at Ikhe Bogdo, but none was seen in the desert region, for yaks are high altitude animals.

FOREST CAMP

Ten miles north of the monastery our trail led abruptly to the crest of a sharp divide, eight thousand feet above sea-level. A magnificent view lay before us. In the bottoms of deep, heavily forested valleys, shining threads of water wound snake-like to the river far away to the east. Fifteen miles away was the Arctic Divide, formed by range after range of snow-crowned mountains.

On the slopes of a side valley, in a beautiful patch of larch forest, we found an ideal camp site. A considerable yurt village lay on the opposite grassy hill-slope, and a spring of sweet, ice-cold water ran off into a tiny brook thickly margined with alders. We returned to the camp at Rainy Gulch thrilled with

anticipation of the days to come. Badmajapoff had decided to visit the Hot Springs at Arishan, fifteen miles away, while we were at the Forest Camp. He was suffering from rheumatism as a result of tortures inflicted by Chinese soldiers during the terrible winter of 1920–1921. Colgate and three of the other men drove over with him, and found that the Prince Regent was also taking "the cure" at the Holy Mountain. They left Badmajapoff comfortably quartered in a yurt, where he was to remain until we picked him up on our way southward after the caravan had arrived.

MONGOL CHILDREN

The night before we broke camp all the Mongols of the little village across the valley gathered at our tents to see the preliminary packing. They were genuinely regretful at our departure, for we had brought much of interest into their uneventful lives. In particular, one little girl twelve years old watched every detail with the greatest attention. When it was almost dark her father said, "It is time to go home now."

"No," said she, "I don't want to go. I want to look at all these things as long as I can. I'll never see anything like them again."

The Mongol children are exceptionally bright and are advanced in knowledge far beyond their years. This is due to the self-reliant life which is forced upon them almost from the time that they have learned to walk. Certainly they are examples of the "survival of the fittest." They grow up as best they can, with no attention to the most ordinary rules of health, cleanliness or diet. From the moment they stop nursing they eat and drink whatever comes in their way. If they are ill, the only medical services are the prayers of the lamas. They must become hardened to the greatest extremes of temperature. Often I have seen babies, only two or three years old, running about stark naked, outside the yurt in a bitter wind, when I was shivering in a fur coat.

When a child is about four years old it is taught to ride a pony. No sympathy is wasted if it falls off; it is only put into the saddle again, and sometimes tied in place. At five or six the children begin to do their bit at herding sheep and goats; a few years later they graduate to the care of camels and ponies. This necessitates long hours in the saddle and often nights alone on the desert. They must learn self-reliance long before their time. They have accumulated most of what their elders have to teach them by the time they are sixteen, and from that age onward they make little mental progress.

THE FOREST OF NORTHERN MONGOLIA

On June 7, we left Rainy Gulch for the camp in the forest. It was by no means easy for our heavily loaded cars to negotiate the trail, because of the steep grade, soft ground and mud holes. With careful handling, however, all

the motors arrived without accident and we camped at noon just within the edge of a beautiful forest.

There was not a breath of wind, the sun lay warm and bright, and the air was sweet with perfume from the larch trees. Beneath our feet was spread a gorgeous carpet of flowers: yellow buttercups, forget-me-nots, purple iris, phlox and a dozen others of rainbow colors. The floor of the forest was thickly carpeted with dead brown "needles," and the larches already showed new buds of brilliant green. Thus, suddenly, we had come into entirely different physical conditions. We were camped on the borderline between the forest and grasslands, and almost at the divide separating the drainage of the Gobi from that of Siberia.

The forest edge is a zone of conflict. There were only two stages in tree-growth represented in the margin of our grove—seedlings and saplings not more than twenty-five years old, and ancient trees, which, judging by their annual rings, were about three hundred and sixty years of age. This would indicate that there was a period of favorable climate when the seedlings were able to get a foothold, followed by a long period of comparative drought on this side of the divide, and a more recent period of moisture. The woodland area in which we were camped was the most southern of all the forest, and the trees have just been able to maintain themselves in their battle against climatic changes. The larch is apparently the only species of tree that has been able to exist. On the other side of the divide, birches are numerous and there is some spruce and pine.

Although there is a carpet of moss under the trees, it is much less thick than that on the northern slopes of the divide; there, the moss is like a mattress, and underneath it the rich black earth is always damp or wet. Because of this lack of moisture there are comparatively few small mammals on the southern slope of the mountains; in fact, even such usually abundant species as *Microtus* are scarce and we caught no insectivores. Across the divide the earth was honeycombed with small mammal runways, and our traps yielded lemmings, *Myopus*, red-backed mice, *Evotomys*, voles, *Microtus*, and a fauna typical of the northern forests.

While the trees are in patches, to the south of the minor divide on which we were camped, the view from the ridge to the north showed an almost unbroken line of forest. Streams, bogs and marshes are present in every valley, and water trickles down the hillsides under the mossy covering. To those who know Mongolia only as a region of grasslands and desert, tales of the beautiful northern forests sound well-nigh unbelievable. I knew its forests well, for in the summer of 1919 I traveled through the great forests north of Urga. It is a land of splendid trees, of luxuriant meadows and gorgeous flowers, as different from the desolate Gobi only a few miles to the south as is day from night.

The fauna is that of the Mongolian-Siberian Life Zone, which is roughly

delineated by the southern edge of the forest. Moose, wapiti, roe deer, wild boar, musk deer, foxes, lynx, sables and squirrels are to be found in greater or lesser abundance. Such typical Siberian Zone birds as the capercaillie, *Tetrao urogallus*, black grouse, hazel hen and ptarmigan follow the trees almost to the border line where they meet the grassland fauna including marmots, spermophiles, jerboas, field voles, antelope, bustards and many species of plains birds.

Our camp was seventy-seven hundred feet above sea-level and even though it was mid-June the nights were cold. Usually the temperature dropped to the freezing point, but the days were delightfully warm and I cannot imagine more perfect weather. We all enjoyed this sojourn in the forests, but, except from the standpoint of zoölogy and geology, it was not very productive. The geologists found that the entire Khangai mountain region was a continuation of the great graywacke series, with nothing to break the monotony except an infaulted Jurassic remnant and a basalt valley-fill near the Ongin River. From the summit of the minor divide near camp we could see several splendid cirques, representing glaciation of an alpine type, in the next range. Berkey, Morris and Colgate made an attempt to reach them, but the trail proved to be impassable for the car and they had to spend the night in the open after an exhausting day. Travel in the forest region of Mongolia is impossible for any wheeled vehicle except an oxcart, due to the mud which lies in the bottom of every valley.

TOWARD THE DESERT FROM FOREST CAMP

On June 13, Merin, our caravan leader, rode into camp. He reported that the camels were awaiting us with Badmajapoff at the Hot Springs. All was well with them except that some of the animals were weak from lack of food; when crossing an arid stretch they had had nothing to eat for three days. The caravan had been attacked by small parties of brigands five or six times, but the robbers had been driven off by rifle fire from several of our men and a Mongol soldier who was attached to the caravan.

We left the forest camp with regret, on June 15, and faced southward toward the desert. Not until we returned to China should we see trees again or have more evenings about the great log fires; henceforth the only fuel would be bits of argul. Nevertheless, we were anxious to be off, for since the first thrilling days of Iren Dabasu no fossil-bearing sediments had been discovered. We had, however, learned much about the peculiarities of the country and the continental structure; we knew that the northern grassland region through which we had been traveling was one of hard rocks, generally running east and west, and that if we were to find eroded sedimentary basins we must turn sharply southward.

Just as we were crossing the Ongin River, near the temple, an enormous drove of sheep, cattle, goats and ponies appeared, and behind them fifty camels, some loaded with yurts and household goods. It was a small Mongol village moving from the grasslands to the summer camps in the mountain valleys. The annual allotment of grazing regions had taken place and this was "moving week" for the Mongols.

Our friends at Rainy Gulch had transferred their village to a valley nearer the temple, and as our cars passed they gathered by the trail to bid us farewell. Nearing the sacred mountain of Arishan, we saw our caravan camped on the summit of a rise directly opposite the Hot Springs.

Badmajapoff delighted us with the information that he had heard from the Mongols of a region, eighty miles to the south, where fossil bones were to be found; bones "as big as a man's body," they said. We thought it was merely native exaggeration, of course, but discovered later that they were not so far wrong, after all.

THE HOT SPRINGS OF ARISHAN

The Hot Springs is an interesting place. The water gushes out from under a rocky ledge, spreading into a multitude of streamlets as it runs down the slope. Just above the spot where the spring emerges from the hillside, an obo has been built, in the shape of a semicircular rampart. Inside the rampart there is a tiny altar, bearing three flat stones upon which are etched pictures of Buddha. Scores of silken scarfs, many faded into a uniform dull white from the rain of countless storms, drape the altar. Some have been whipped to ribbons by the wind; others are new and as blue as the sky above the shrine. These are the offerings of pilgrims who have come to bathe and to drink the sacred water.

The shrine is the "holiest of holies" and we were asked not to step within the obo circle. A lama showed us a nest of vipers beneath a stone; indeed, the whole vicinity of Arishan swarms with vipers. When they crawl into the tents and yurts, the natives gently shoo them out the doors. No life may be taken at this place; not even an insect or a worm is killed if it can be avoided.

At intervals along the various streamlets, pools have been built in the rocks; over each a tent or yurt is placed. The pool farthest up the hillside near the shrine is the place of honor and is reserved for the Prince, or Ta Lama of Sain Noin. Badmajapoff had a bathing tent next that of the Prince and, after a brief inspection of the place, Granger and I went in for a bath. The water was crystal clear and only slightly sulphurous.

A cold spring flows out near the hot one and this has been diverted in tiny branches to each bathing pool; thus one can control the temperature of one's

bath by damming up or widening the cold stream. The actual temperature of the water where it issues from the ground is 127° F.

The mountain, Arishan, from the base of which the hot water gushes forth, is all sacred ground. It is little to be wondered at, this worship of the spring. Imagine a caravan in the bitter days of winter, when the wind cuts like a white-hot brand, winding over the hills and pitching its tents on the plain. When the loads have been lifted from the tired camels, the half-frozen nomads walk across the valley to find a spring of steaming water bubbling from the frozen earth, offering health and comfort. What better evidence could there be of direct connection with supernatural powers!

Doubtless this mountain has been the object of pilgrimages through ages. Indeed, we found evidences of an ancient edifice in a chaotic mass of rocks below and at the side of the spring. They appeared at first to have been washed there by some violent flood, perhaps from a cloudburst on the mountain slopes, but upon closer examination we discerned unmistakable evidences of an orderly arrangement of the large blocks; moreover, some were foreign to the mountain at the foot of which they rested. There is little doubt that they formed the base of a huge shrine or ceremonial building at some time in the far, dim past. Perhaps those pre-Mongol people whose graves we found in the grasslands had constructed an altar here! Perhaps it was before their time and they themselves had built upon the ruins left by still older tribesmen. Thus, the present shrine above the spring has been built by the Mongols upon a foundation of these ancient blocks.

Regarding the scientific reason for the Hot Springs, Professors Berkey and Morris, 1927, have said:

"The holy spot lost none of its charm for us because it happened to fit our purpose to study the mystery itself, for it is one of the type geological localities of northern Mongolia.

"We found a great fracture in the earth's crust at the base of the mountain, and the strata have been displaced along it so that one side has dropped down several thousand feet. Taking advantage of this weakness, volcanic lavas have attempted to break through the fault zone, but their energy died out before much of an outbreak was accomplished. They came so near the surface, however, that even to-day one can find a few fragments of volcanic rock lying about on the ground, and probably there is much more below. Now, the rain that falls on the adjacent hills and sinks into the ground finds its way into the fractured zone, following along the hillside and under the valley till it encounters the lava below, which must still be hot. Heated by the lava, the waters rise of their own accord, issuing as hot springs."[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, v–xxxi, pp. 1–475.

The geologists had an extremely busy time at the Hot Springs, because they decided to make a detailed map of the locality. From daylight until long after dark they worked so feverishly that I was seriously concerned for their health.

THE PRINCE OF SAIN NOIN

On our first day at Arishan we called upon the Prince, or Ta Lama. He made an exceedingly pleasant impression upon all of us. About thirty years old, rather small in stature, but well-formed, he has a delicate, sensitive face and fine eyes. His skin was very white—much lighter in color than our own faces, which were tanned by the sun and wind. Doubtless there are some lamas who take their religion seriously, from the purely religious point of view, but I have met very few of them. The Prince was a shining exception. Not only does he conform to the Buddhist principles in being a true celibate and avoiding wine and tobacco, but an inner goodness "shines" from his face. His expression is rather sad but singularly gentle, and there is a quiet dignity in his carriage and in every action. When in repose he unconsciously assumes a Buddha-like attitude and one feels that he has attained absolute mental composure. He smiled sometimes but I never saw him laugh. We asked him to dinner at our camp, and I noticed that he watched the ways in which we handled our knives and forks in order that he might not make mistakes. The ordinary Mongol, of course, eats with chop-sticks or his fingers.

The Prince was interested in everything—not a childish curiosity, but a real desire to understand the extraordinary things in our equipment. A carbide lamp delighted him and he comprehended at once how the gas was formed. He never tired of investigating the internal anatomy of the motors, and the only time that I saw his habitual calm disturbed was when he was allowed to steer the car which carried him back to his yurt. For a few moments his face wore an expression of intense delight. I have written somewhat at length concerning the Prince because he is by far the most remarkable Mongol whom I have ever met.

THE VALLEY OF THE SACRED MOUNTAIN

The valley of the Sacred Mountain swarmed with antelope and at this date (June 17) they had just assumed their full summer coats. They were all of the species *Procapra gutturosa*, because the desert gazelles never range so far into the grasslands. The valley was a very populous place during our stay there. As I have remarked, this was "moving week" for the Mongols, and dozens of families, with thousands of sheep, goats, cattle, ponies and camels, passed northward to the mountains. Usually they arrived early in the afternoon and were gone at daylight in the morning.

PLATE XXI.

A. YAKS IN THE FOREST REGION OF NORTHERN MONGOLIA.

B. PRINCE REGENT AT SAIN NOIN KHAN.

PLATE XXII.

CAMEL AND MOTOR CAR TIRES, SHABARAKH USU.

A large family on the march is an interesting sight. The great herds of goats, sheep, cattle and ponies are driven along rapidly in front by mounted herders. The camels travel in the center bearing the yurts and household goods packed in neat bundles; behind ride the men and women on camels and ponies. The babies are packed in wicker baskets on either side of a camel, and it is most amusing to see their little heads and bright eyes peering down from the huge animal. Since the transient visitors were on the move shortly after sunrise, it was difficult for Shackelford to record all he wanted in motion pictures. They must always arrive at their new camping spot early enough to give their stock several hours of grazing before being gathered in for the night.

CHAPTER IX

SOUTHWARD INTO THE DESERT

SOUTHWARD FROM THE HOT SPRINGS OF ARISHAN

On June 15, we sent the camels southward to the edge of the desert, where the feed was better suited to these strange animals. The spot was on the route which we would follow to the fossil locality reported by the Mongols. We ourselves left the Hot Springs three days later. We drove down the valley until we reached the faint path which marked the Uliassutai trail. All Mongolia seemed in motion, for every mile we passed newly pitched yurts, with the sheep and goats gathered in closely packed units or scattered over the plains. Antelopes, too, had joined in the migration toward the mountains and were moving northward in great herds.

The trail led us up and down a series of grassy hills, each being steeper than the last, until, after an almost perpendicular climb, we started down a long gentle slope where the cars coasted for miles. It took us to the bottom of a wide valley in which a single yurt was pitched beside a tiny stream. For twenty miles the trail had been deserted, and we realized, from the rapidly thinning grass, that we were nearing the desert's edge. Crossing the stream, we turned straight south down the valley, and at five o'clock in the afternoon, from the summit of a hill, we sighted the blue tent and grazing camels of our caravan.

THE BASIN OF GORIDA

The trail had taken us over a country composed mostly of graywacke and granite rocks. Our Mongols had camped at the base of an extraordinarily picturesque mountain range of bathylithic granite. The bare, jagged peaks showed dim and ghostly against the sky, in the sunset haze; the terrain was fine gravel, studded with clumps of long grass, stiff and hard. Already camel sage and low thorny bushes had begun to appear. It was in truth the edge of the desert, even though we were only fifty-four miles south of the Hot Springs in the midst of the grasslands.

Merin said that the feed was excellent for the camels—sagebrush and

thorns! The camel is in truth a relic of the Pleistocene, and his tastes are just as peculiar as his appearance. In the midst of sweet green grass he languishes and grows thin, but put him among the thorny desert vegetation and he is happy. His humps and belly grow fat and round, and he stores up nourishment enough to last him for months of scanty food. All our camels were in good condition, but badly in need of rest and an opportunity for uninterrupted grazing. The felt strips, which are wound around and around the humps to form the "saddle," had not been removed since March 20, except for the examination of some individuals with sore backs. Therefore, I told Merin to remove them all, and that we would let the camels feed while we prospected the surrounding country in our cars.

Our camp in the basin, which the Mongols called "Gorida," was only a short distance from the Arguin Gol, a shallow stream. A mile away was a small saline lake, surrounded by enormous "nigger heads," and three miles east we could see a much larger body of water shining in the sunlight. Several good springs near the river afforded drinking water.

Both lakes were abundantly inhabited by breeding waterfowl, bar-headed geese outnumbering all the rest. The young were about one-third grown, and I spent a most interesting hour watching the parent birds piloting their broods to hiding places on shore at signs of danger. The little fellows were adept at concealing themselves in the thorny vegetation which covered the gigantic "nigger heads." The female geese would not desert their young under any circumstances, but the mallard ducks were by no means as constant.

As far as I can remember Gorida was the only camp in Mongolia where we were really annoyed by sand-flies. These insects quickly drove us into the tents, where they would not follow if a canvas floor-cloth had been spread. We could sit in perfect comfort a few feet inside the tent door, whereas outside it was most unpleasant. The absence of biting insects is one of the most delightful things about camp life in the Gobi; such pests are present in so few places that they can virtually be eliminated from one's calculations. In the northern forests, however, this does not hold true; there flies and mosquitoes are ordinarily troublesome.

I was most impressed by the abundance of bird and animal life here at the edge of the desert, in comparison with the forest which we had left so recently. There the woods were nearly deserted except for a few species of birds, which were not abundant. Here, birds were everywhere. Our traps held so many small mammals that the three taxidermists were busy every moment; at the forest camp I set fifty-one traps one night and not one was sprung the next morning. Of course, this was partly due to the fact that the woodland on the south side of the divide, where we were camped, was much

drier than that on the northern slope. Nevertheless, I have found that, as a rule, the evergreen forests in northeastern Asia do not have abundant bird or animal life, as compared with the deserts.

THE "POST ROAD"

Our tents were pitched a hundred yards from the Kalgan-Sair Usu-Uliassutai trail. This is an ancient highway, which, after the Chinese had conquered the Mongols, had become one of the most important routes across the desert. It was known as the "Post Road." Branch trails leave it for Urga and Kobdo, and subsequently we found that for much of its way wells have been dug every ten miles. It was along this trail that Chinese officials traveled on their visits to the important administrative centers of Mongolia, and at several points the ruins of Chinese mud rest-houses could be discerned.

This Sair Usu trail is still a trade artery through the Gobi. From our camp we could see the blue tents of a great Chinese caravan, a mile away. They remained there for two days, resting and allowing the camels to graze. The night before we left for the south the caravan took to the road. Just as twilight was fading into night we heard the mellow *dong, dong, dong* of deep-toned bells, and saw a long line of curving necks and huge bodies loom against the eastern sky. They came slowly toward us, two hundred camels in groups of twenty, a phantom-like procession. These grotesque bodies, moving almost without a sound as their padded feet trod the sand, passed and disappeared toward the glow of the western horizon. For me there is no more weird and ghostly sight than the silent progress of such a caravan through the desert night.

I talked with two of the Chinese. They were Mohammedan merchants from Kweihwating, in Shansi, bound for Uliassutai with tea, cotton cloth and tobacco. Five months later they would return with skins and wool. Perhaps they might also drive home a herd of ponies to sell to the farmers in north China. Year by year merchants make these journeys to the heart of central Asia, exactly as their ancestors did a thousand years ago. The Chinese eagerly asked us for news, and we were able to give them some, for they had left China weeks before we had started from Kalgan.

THE EASTERNMOST ALTAI RANGES

From the granite crags near Camp Gorida, we could look southward across a great basin to two prominent mountain ranges. The nearer, almost thirty miles away, was Mount Uskuk; far beyond and towering above it was Baga Bogdo, of the eastern Altai.

The great Altai system extends southeastward into the Gobi. Toward its eastern end it becomes lower and less rugged and breaks up into partly

PLATE XXIII.

MONGOL VILLAGE NEAR ARTSA BOGDO.

The village was situated on the edge of a meadow-land watered by streams flowing down from the mountain. 1925.

A. [illegible]

B. MONGOLS INSPECTING FLASHLIGHTS

isolated ranges and spurs, which gradually lose their identity and merge into the rolling desert. Baga Bogdo, the "Lesser Buddha," is one of these partially separated groups. The snow-crowned summit of the highest peak lay against the background of blue sky, glittering like a pure white diamond. In the great desert basin, and at its feet, we hoped to find fossil-bearing sediments.

We had had delightful weather, but on June 20 a storm blew up and the temperature dropped to freezing, even though it was June. All of us pulled fur coats out of our duffle bags, and shivered in the gusts of hail and snow which whirled into the tents. The weather changes of Mongolian spring are kaleidoscopic. A day of hot weather, when one is comfortable only in the thinnest of clothes, may be followed by a drop of thirty or forty degrees of temperature in a few hours. One cannot be really sure that summer has come to stay until the first of July.

ACROSS COUNTRY TOWARD MOUNT USKUK

The Mongols at the Hot Springs of Arishan had told us that at Gorida we would be able to find a guide who could take us to the locality where fossils had been reported. Colgate and Badmajapoff spent all day of June 19 driving about the country, trying to find a certain "rich man"; he could not be discovered, but at last they came to a village of six yurts and were directed to the poorest man in the whole region. His yurt consisted of a few pieces of felt tied together; his worldly possessions included one wife, one horse, one sheep and one goat. Still he appeared well-fed and happy, although, like "Gunga Din," his clothes consisted of nothing much before and rather less than half of that behind. He appeared to know a good deal about the country into which we wished to go, and readily agreed to come with us if he could borrow three of our camels to take his wife and possessions to a friend ten miles away, who would look after them in his absence.

Our guide directed us straight across country, where there was no trail, toward the base of Mount Uskuk. It was his first experience in a motor car—indeed, he had never even heard of such a thing before—but he was prepared to enjoy himself to the fullest. Granger gave him a cigar, which was also new to him, and he settled back in his seat beside me with an expression of the most sublime delight upon his face.

A LAKE OF SALT

About fifteen miles from camp we crossed a low ridge, into a considerable basin, and saw a brilliant white lake glistening in the sunlight. It proved to be a salt lake—or rather, a lake of salt, for the surface was a solid crust of salt, several inches thick. Near the eastern end, half a dozen Mongols, with as many camels, were gathering salt. We ran along the shore on sand as hard

and smooth as a sea beach and halted for tiffin near the Mongols, for the place was too picturesque to pass quickly.

Shackelford set up his motion-picture camera and found an excellent actor in a little bowlegged Mongol. We made him understand that we only wanted him to do his usual work, without looking at the camera. With a most serious air the old fellow grasped his pail, walked resolutely through the mud to the fresh crust away from the shore, broke off enough salt to fill his bucket, and came in again to spread it on the ground to dry.

Our movie star had with him an attractive Mongol girl, who was left in charge of the camels. When the photographing was ended we presented the old man with an empty gasoline tin and gave the girl a dozen pictures of actresses, torn from an American magazine. She was too embarrassed to do more than smile faintly, but the way she clasped them to her breast while holding the camels' rope with the other hand showed how much she valued them. A few moments later, when our motors frightened the camels and they began plunging in all directions, she dropped the papers and a gust of wind swept them over a hill. For a moment she stood irresolute, looking at the camels legging it down the beach, then dashed after the precious pictures, leaving the animals to go their way.

The salt was as pure and white as though it had been refined for table use. The thick crust lay on a bed of soft black mud. I never have seen another deposit of salt so beautiful anywhere in Mongolia. I was surprised to find how comparatively little salt the Mongols use. In most parts of the desert it is not difficult to obtain, for usually the small interior lakes are more or less saline, but the natives prefer their meat, butter and other animal products unsalted. They like sugar very much, but I never found a Mongol who had any in his yurt, and it can be obtained only from passing Chinese caravans; sweet chocolate is not much appreciated even by the children.

In regard to our salt lake, Berkey and Morris, 1927, have remarked: "The little dry lake has no outlet, but there must have been a time, not long ago, when this was simply a portion of a valley through which a stream ran, and there must have been an outlet through which most of the material, now missing, was carried. But the present bottom is a series of undrained hollows, and there is no semblance of a stream course in its minor features. It is evident that something else has modified the form, and the only agency that could have done it is the wind. Here in the basin immediately north of Mount Uskuk, as in many other places, the wind is eroding and modifying in a minor way the sculpture work of former streams. There is thus a superposition of topographies by different successive agencies."[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, v–xxxi, pp. 1–475.

BADLANDS NEAR MOUNT USKUK

We circled the lake and headed for a pass at the foot of Mount Uskuk, which stands more than fifteen hundred feet above the salt basin. Tucked away in a fold of the hills were three yurts. While we were still more than a mile away, Shackelford shot at a flock of sand-grouse, and immediately we saw the Mongols, on horseback and afoot, fleeing into the ravines like frightened rabbits. This happened not once but a score of times during the summer. It is grim evidence of what terror has been instilled into these peaceful dwellers of the desert by the tragic events of the last two years. At half a dozen places we heard the most gruesome stories of wholesale murder, and a rifle-shot or the sight of a single motor was enough to send an entire village into the hills.

When we gained the summit of the first ridge and looked down into a gray-green desolation of ravines and gullies, Granger and the geologists agreed that these were Tertiary sediments and that evidently we were coming into a "badland" basin of considerable extent.

As we looked over the country to the south, Colgate and I wondered how it would be possible to get the motors through these "badlands." It seemed as if nothing on wheels could go down the almost perpendicular sides of the ravines and get out again. The old Mongol said that there was a pony trail close to the side of Mount Uskuk, and while the geologists were away I prospected it. The guide was quite correct in saying that it was a "pony trail," for we can all swear that it was never meant to be traversed by anything else. During the next four hours we took the cars into seemingly impossible places. Walls, rocks, ravines, washouts and ditches followed one another in rapid succession. Only Colgate's good driving got us through without a smash.

CAMP ONDAI SAIR

At last we crossed the pass and were confronted with a broad river-bed of loose sand. This ended our troubles, and we camped at a well of sweet water, called Ondai Sair, only a mile on the other side. A yurt stood on a broad shelf, beside the well, surrounded by a flock of sheep which grazed eagerly on the fresh green grass where the ground was watered by the overflow. All the rest of the plain and the encircling hills were desert-like in the extreme—a floor of fine, sandy gravel scantily carpeted with sagebrush and hard bunch grass.

Directly to the south of the valley, Baga Bogdo stands like a huge rampart. Bathed in the violet light of sunset, it seemed like a fairy mountain. We were all in high spirits, for it was evident that we stood at the entrance to a great sedimentary basin, splendidly exposed.

The Mongols at the well said that they had come that day from the desert to the south. In the morning, when they had gone to collect their ponies, a wild ass was with the animals. That also was good news, for I was particularly

anxious to obtain a group of wild asses for the Hall of Asiatic Life in the American Museum. The Mongolian species was but imperfectly known, and no museum in America possessed specimens of it.

The following day the geologists, with Granger, Colgate, Larsen and the guide, took a car down the valley to the spot from which the Mongols had reported fossils. At half past seven in the evening the exploring party returned. They reported the way down the valley to be very bad indeed, but possible for the cars. They had found a rather dirty well and a fine spring, and, in a three-hour search, discovered a few bone fragments. These were not very impressive but were sufficient to show that the strata were fossil-bearing. The country, they said, was like our western badlands in America—bare sedimentary hills and plains much opened by ravines and gullies and dotted with sculptured buttes. Moreover, through the glasses, Granger had seen a wild ass comfortably switching flies as he drowsed in the sun. Altogether it was distinctly encouraging. Because of the bad going down the valley, we decided to stay where we were until Granger and the geologists could give the surrounding country a rapid survey from the palæontological standpoint.

FOSSILS FROM THE CRETACEOUS ONDAI SAIR FORMATION

It was necessary, however, to remain longer than we intended, for on Friday, June 23, winter fought a desperate rear-guard action with summer before accepting final defeat. Rain, hail and snow, with a temperature below freezing, kept us in our tents, but two days later a smiling sun sent us happily on our separate ways into the field.

Granger returned about sunset with no mammalian fossils, but he reported a considerable deposit of insects, crustaceans and small fish, in "paper-shales."

The geologists did not come in until nine o'clock. They said they had found fossils but would tell little until after dinner. Then their spoils were spread out upon the table. They had many fragmentary bones, but these were so broken that it was impossible to identify them. Nevertheless, Granger felt sure that one portion of a leg-bone which Doctor Berkey had found must be dinosaurian. If that were true, it meant that the formation from which they had come was probably Cretaceous. As the geologists had seen no Cretaceous beds since leaving Iren Dabasu, this would be an important discovery.

We remained far into the night, examining the specimens and discussing the possibilities which had been opened by the day's work. These were the hours which I enjoyed most of all, and they will remain vividly in my mind when other memories have faded with the passing years. The fish, insects, crustacea and plants proved to be most interesting and important. Some of the forms were new, but a fauna which is in part identical with it has been reported from eastern Siberia. The geologists believe that these paper-shales

were formed in sheltered ponds of such quiet water that insects which died upon the surface sank to the bottom and were gently covered with a blanket of the finest sediment. In this matrix their tiny bodies left perfect impressions as the animal matter decomposed. The shales could be separated into sheets as thin as paper, and some of the specimens were so beautifully preserved that the delicate wings of giant May-flies, *Ephemeropsis*, were almost perfect in detail. One wing was 35 millimeters in length.

The small fossil fishes, *Lycoptera middendorffi*, were exceedingly abundant in the paper-shales. They represented a new family, Lycopteridæ, which is apparently ancestral to the Cyprinidæ, according to Professor T. D. A. Cockerell[1] who identified them.

A dinosaur skeleton, of which I will speak later, was subsequently found by Granger in this region. The formation was designated as the Ondai Sair and has been ascribed to the Lower Cretaceous.

FAUNA AT CAMP ONDAI SAIR

The camp proved to be just as interesting zoölogically as from the geological and palæontological standpoints. My traps yielded a rich variety of small mammals. Most of the species proved to be new to my collection and several of them new to science. In addition to marmots, spermophiles, kangaroo rats, hamsters and voles, I caught specimens of *Lagurus przewalskii*, a pale yellowish mouse with very small ears, minute tail, and feet with heavy soles, which I had never seen before. It was originally described from Tibet, and its range thus is extended some eight hundred miles to the northeastward. Another new animal was a very beautiful jerboa which Dr. G. M. Allen, 1925, has named *Stylodipus andrewsi*.

A great slide of broken sandstone behind camp was inhabited by numbers of picas or conies, *Ochotona pallasi*. One of my traps held a full-grown male, alive but with its back broken. I took the little fellow to camp, and although the hindquarters were paralyzed it appeared to be in no pain and ate grass-roots greedily; neither did it exhibit the slightest fear. This was due, presumably, to the nerve shock which it had sustained.

We also found hares fairly abundant. Dr. G. M. Allen, 1927, considers this species to represent *Lepus tolai tolai*, which has a wide range throughout the Gobi Desert.

It was interesting to encounter marmots again, for we had seen none since leaving the grasslands. Their presence was due to the proximity of the Altai Mountains. We discovered later that the typical fauna of the far western

[1] Cockerell, T. D. A. 1924. "Fossils in the Ondai Sair Formation, Mongolia," *Bull. Amer. Mus. Nat. Hist.*, LI, pp. 129–144; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 37, pp. 129–144, 1926.

Altai had followed the long finger of mountains eastward as it reaches into the desert, thus giving a much extended distribution not only to mammals, but to several species of birds.

GEOLOGICAL MAP OF THE MOUNT USKUK REGION

It was so apparent that we were in an extremely important region that Berkey and Morris decided to make a geological and topographical map, from the salt lake straight south down the valley, as a type section of Mongolian geology. It was a colossal undertaking with the limited time at their disposal. Since they had no other assistants and could not use a motor in that rough country as they had done at the Hot Springs, we hired two diminutive ponies from a Mongol lama whose yurt was five or six miles from camp.

Granger thought it wise to go with us to the well at the southern end of the valley, where I wanted to hunt wild ass. If the geologists found important fossil beds in their survey he could return for a thorough exploration.

WILD ASS CAMP

On June 26, we left the geologists with one car, a chauffeur, a cook and a Mongol camp assistant. The rest of us turned southward toward the well ten miles away. The going was not as bad as we had expected, for in the lower part of the valley the sandy river-bed had become so solidly packed that the cars could run upon it as upon a floor. Then we climbed to a gravel plain which slopes gently southward from the base of a range of low lava-covered mountains to the foot of Baga Bogdo thirty miles away.

The tents were pitched above and to the west of the well and spring. This camp we later named "Wild Ass Camp." The country was desolate but strangely fascinating. From the door of my tent I could look south to the splendid mass of Baga Bogdo, its snow-capped peaks whiter than the clouds which always drifted about their summits. In the distant foreground was a long, flat-topped ridge, blood-red except for an upper gray-white stratum. Nearer were other hills and buttes of red, white and yellow, cut and sculptured by the winds and rain. To the west the gravel plain, sparsely studded with desert vegetation, stretched away to meet the black mass of a lava flow; east of us across the wide river valley a similar gravel plain, extending far beyond the range of human sight, lost itself in the ever-changing mirage.

Summer had come in a day and breathless stillness lay upon the desolation of painted badlands. The flowing waves of heat gave weird fantastic shapes to rocks and grass; antelopes seemed to dance on air and flying birds to run upon the ground. Lakes with reedy shores and wooded islets appeared where we knew there were no lakes, and somber forests offered the coolness of shaded glens. It was an unreal world, menacing yet alluring.

As I was gazing across the plains, the sky darkened and a subdued roar came out of the north. I felt a sudden blast of cold air and turned to see a storm sweep from the river valley and rush away to the west at race-horse speed. In its wake lay a narrow trail of white hailstones, as large as pebbles. A moment later the desert was flooded with yellow sunlight which seemed to have passed through amber glass before it reached the plain. Throughout the summer this narrow track over which the hailstones were spread remained as a well-defined band of green. Thus quickly does the desert respond to the slightest moisture.

Larsen was standing beside me, watching the rush of the storm through field-glasses. Suddenly he gave an exclamation and pointed to a cloud of dust less than a mile away. In the midst of it we could see three dun-colored animals. They were wild asses! One was standing quietly while a huge stallion chased the other in circles.

Five minutes later, Colgate, Larsen, Shackelford and I were in a car speeding toward them. We were all excited for it was our first sight of a new animal and one we had come far to seek. While we were still half a mile away they began to run west by south but going rather slowly, now and then stopping to glance back at us. They looked very neat and well-groomed in their short summer coats, and galloped easily. Suddenly they disappeared in a shallow draw with a narrow rocky entrance where it seemed we could not follow. Colgate jammed on the brakes, and by the time they were in sight on the opposite side we had opened fire, but they were beyond the range for accurate shooting and our bullets did no harm. They ran south from the valley into sandy ground where we could make no speed. Reluctantly we admitted that they had outgeneraled us. On the way back to camp we saw four more asses—two mares, each with a colt,—but they, too, kept to the sandy plain and left us far behind. The first chance had given us valuable experience, for we realized that it was useless to follow the animals when they were south of the gravel plain on which the camp was pitched.

Twenty miles from our "Wild Ass Camp" was a large body of water called Tsagan Nor (White Lake). We could see its glistening surface distorted by the dancing mirage and the guide said that wild asses were very abundant near its shores. The low ground, however, was so difficult for the cars to traverse that we did not reach the lake until two weeks later, when Shackelford and I discovered a practicable route.

A *BALUCHITHERIUM* SKULL

The day after our arrival at "Wild Ass Camp" I found my first important fossil. We could prospect within a dozen yards of the tents, which were on the edge of a red and white wash. In the morning Shackelford found a

beautifully preserved foot bone, of unidentified rhinocerotid type, in the bottom of a deep ravine. I was stimulated to better his discovery. After setting a line of traps in the river bottom near the well, I was wandering slowly along the sides of the ravine looking for fossils. Fragments were abundant but none was identifiable or worth keeping. Suddenly my eyes marked a peculiar discoloration in the olive-green upper strata; then I could see bits of white which looked like crumbled teeth. Scratching away the soft clay-like earth, I exposed the grinding surface of some large teeth and realized that it was something interesting. There was an almost irresistible temptation to dig further and see what lay below, but I knew that if I did the wrath of the palæontologist would descend upon my head. The teeth were literally in powder, and fell apart in a thousand tiny fragments when the supporting earth was removed. Because of its bad state of preservation, Granger was doubtful at first whether it would be worth while removing the specimen, but eventually he decided to make the attempt.

It took four days of intermittent work to get it out, and no one but a master of the technique like Walter Granger could have accomplished it at all. By means of a fine camel's-hair brush, he removed the sand almost grain by grain, wetting the teeth with gum arabic as each minute section was exposed, and stippling Japanese rice-paper into the crevices. When the gum and paper dried, the dust-like particles of enamel were so cemented that it was safe to expose a still larger surface. Then Granger soaked strips of burlap in flour paste and bandaged the fossil as though it was a broken limb; after a day of sun this formed a hard shell in which the specimen was safe.

As the work progressed it became evident that much more than a set of teeth lay buried in the hill; one side of the palate was exposed, then the jugal arch which forms the cheek, and finally the anterior part of the skull with a pair of extraordinarily long, decurved nasal bones. The teeth showed that the animal was a rhinoceros of a kind that none of us knew. Subsequently it was studied by Professor Henry Fairfield Osborn, 1924, who named it *Baluchitherium mongoliense*. The formation was designated as the Loh, from the name of the region, and the age determined as Lower Miocene. It was in this same layer that Granger discovered the remains of a serrate-toothed mastodon, named by Professor Osborn *Serridentinus mongoliensis*.

My initial experience as a palæontological collector made me very keen. Every find was pregnant with the most interesting possibilities, for the veriest fragment of exposed bone might lead the way to a skull or skeleton; moreover, each specimen turned one more page in the prehistory of central Asia. In every leisure moment I wandered over the badlands hunting for new treasures, but I was far behind Shackelford as an amateur collector. In some uncanny way he seemed to know exactly where the best specimens lay, and he always

came into camp with his hands or pockets full of teeth or bones which it seemed no one else could find. We were certain that he had developed an extra sense whereby he could smell an animal that had died millions of years ago. Granger was pleased at our efforts to discover fossils but his approval ceased abruptly when it came to removing them. My favorite tool was a pick-axe, while he used a camel's-hair brush and a pointed instrument not much larger than a needle. When a valuable specimen had been discovered he would suggest that we go on a wild ass hunt, or anything that would take us as far as possible from the scene of his operations.

A FOSSIL SPADEFOOT TOAD

In the red clays Granger found a small but highly important specimen. It was a beautifully preserved spadefoot toad. Dr. G. K. Noble, who described it and named it *Macropelobates osborni*, says it "is of unusual interest as representing the group from which the modern spadefoot toads arose, to spread on one side across Europe and on the other into North America. It is the oldest-known fossil which belongs unquestionably to the Pelobatidæ. . . .

"The formation consists mostly of sandy clays. The terrain during Oligocene times was therefore similar to that to which modern spadefoot toads are restricted, except that it may have contained more clay and less sand. The climate was apparently semiarid."[1]

FOSSIL-HUNTING IN THE BADLANDS OF LOH

We very shortly discovered a well-marked trail two miles south of "Wild Ass Camp." It ran east and west, and subsequently we learned that it was a main caravan route from Kweihwating to Kobdo. Although in many places it goes through very sandy country, still it has been beaten so hard by the camel traffic of centuries that our cars could run upon it as well as on country roads in America. Shackelford and I followed it one day ten miles to the westward. It led us into a vast dry river valley filled with deep red buttes, and knolls and sculptured pinnacles. To the west was the gently rolling plain, slashed by shallow gullies; to the north the low mountain range of the Uskuk block, capped with lava, the red sediments appearing like vivid wounds from beneath the dull black shell. We named this trail the "Grand Canyon." Subsequently it proved to be a rich fossil locality of the Oligocene Hsanda Gol formation.

Eastward from camp the plain breaks up into a much dissected region which yielded a few valuable small fossils but in which good things were rather rare. Except for a small deposit of Pliocene sediments at the foot

[1] Noble, G. K. 1924. "A New Spadefoot Toad from the Oligocene of Mongolia, with a Summary of the Evolution of the Pelobatidæ," *Amer. Mus. Novitates*, No. 132, p. 1; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 27, pp. 1–15, 1926.

of Baga Bogdo, which we named the Hung Kureh formation, the three localities which I have mentioned were our most fruitful palæontological hunting-grounds.

Fossils were very abundant in and on the badlands at the "Wild Ass Camp." All the members of the Expedition—Chinese, Mongol and foreign—became so interested in hunting bones that they spent every available moment wandering over the hills and into the ravines. My own work in zoölogy and the general direction of the Expedition kept me so occupied that I had little time for anything else, still I usually reserved the evening hours for a walk over the bone beds. Then the wind died out, leaving a solemn stillness over the desert, bathed in the golden light of sunset. Baga Bogdo assumed her evening dress of lavender, changing to violet as the twilight deepened; her rugged outlines were softened and clothed in an ethereal majesty; she seemed like a beautiful cloud that had settled to rest for a moment upon the earth. The mountain affected all of us strangely; even the natives felt its spell and loved to sit gazing with field-glasses into the mysterious depths of its darkened canyons.

Over the red and brown buttes and hillocks, thousands of rodent jaws and skulls had weathered out. In places it seemed as though they had been sowed like grain with a lavish hand. Some of the smaller skulls were in soft concretions while others were almost clean. Teeth and skulls of a queer, gopher-like, giant bathyerid, *Tsaganomys altaicus*, a new genus and species, were abundant, as well as another new rodent, *Cyclomylus lohensis*. The late Dr. W. D. Matthew, who studied the collection of specimens, remarked: "It suggests the Asiatic ancestry of the family, although it cannot be considered as even approximately ancestral to the living genera."[1] In our first summer's work here, eleven species of fossil rodents were obtained, of which seven represent new genera.

Remains of small carnivora were discovered in numbers. The new species, including two new genera, already have been described by Doctor Matthew, 1924. Insectivora numbered only four new species and one new genus. The Perissodactyla are represented by two genera and species and the Artiodactyla by one. The single representative of the Artiodactyla, *Eumeryx culminis*, is of particular importance because Doctor Matthew believes that it fulfils "more nearly than any hitherto described the required characters for an early Oligocene direct ancestor of the Cervidæ."[2] All seem to represent

[1] Matthew, W. D., and Granger, Walter. 1923. "New Bathyergidæ from the Oligocene of Mongolia," *Amer. Mus. Novitates*, No. 101, p. 4; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 19, pp. 1–5, 1926.

[2] Matthew, W. D., and Granger, Walter. 1924. "New Insectivores and Ruminants from the Tertiary of Mongolia, with Remarks on the Correlation," *Amer. Mus. Novitates*, No. 105, p. 4; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 22, pp. 1–5, 1926.

an Oligocene stage of evolution and the deposit of red and brown clays was named the Hsanda Gol formation.

SUMMARY OF THE HSANDA GOL FAUNA

In closing a brief summary of this fauna Doctor Matthew, 1924, remarked:

"The character of the *Baluchitherium* fauna is peculiar as compared with most Tertiary mammal faunas, in the great abundance and variety of rodents and small carnivora, and scarcity of ungulates, especially artiodactyla. It represents probably a somewhat different facies from the badland faunas of western America, or the fissure and quarry faunas of western Europe. It may perhaps be a desert basin fauna. The association of true though primitive Cervidæ with a fauna rather closely correlated with the older Oligocene of Europe and America is of importance as indicating the Asiatic origin of this group, if the principles of evolution and dispersal be adopted which were outlined by Matthew in 'Climate and Evolution.' Hasty conclusions, however, are to be deprecated, as the evidence is still scanty and imperfectly studied and there is excellent prospect of obtaining more of it in the near future."[1]

THE GEOLOGIC RELATION OF THE BEDS IN THE TSAGAN NOR BASIN

During the weeks that we remained in this great Tsagan Nor basin, Berkey, Morris and Granger, 1923, made a study of it from the combined geological and palæontological standpoints. An abbreviated review of their conclusions follows, recording the section from the oldest to the youngest.

Upon the oldrock floor, consisting of schists, marbles, graywackes and slates, all of pre-Cambrian age and invaded by granite, lie, near Mount Uskuk, the Ondai Sair sands and paper-shales of Lower Cretaceous age. These are at least five hundred feet thick, and are faulted and tilted. It was in the paper shales that fish, insect and plant fossils were found. Resting unconformably upon the Cretaceous, lie about thirty-five hundred feet of early Tertiary gravels, sands and sandy clays. They include at least one lava flow. The higher beds are judged to be of Lower Oligocene age and are called the Hsanda Gol formation. They carry the *Baluchitherium* fauna.

A layer of clays less than one hundred feet thick is imposed upon the Hsanda Gol and is named the Loh formation. These upper beds are sparingly fossiliferous; the fauna indicates that they are Lower Miocene.

Near the base of Baga Bogdo are later deposits of sands and clays, perhaps two thousand feet thick, judged to be of late Pliocene age, and designated the Hung Kureh. Of still later age is the mantle of coarse rubble, derived from Baga Bogdo and flanking the mountain, which is at least two thousand feet

[1] *Op. cit.*, p. 6.

thick and, so far as we know, is unfossiliferous. It may be very late Pliocene or Pleistocene.

The thickness of the exposed sediments in the basin is between eighty-five hundred and ten thousand feet. Only a fraction of these strata was accumulated in any one period. This basin, which contains the oldest and the youngest basin sediments of which we have record, is the longest-lived and most active basin we have yet observed in Mongolia.

CHAPTER X

WILD ASSES AT TSAGAN NOR

SECURING THE FIRST SPECIMEN

THE Tsagan Nor basin was exceptionally well suited to our purposes, for it furnished work for all the members of the Expedition. Berkey and Morris had a splendid type section of Mongolian geology to study and map; Granger and his assistants were busy every moment with an abundance of new fossils; Shackelford reaped a harvest of motion and still photographs, and my hands were more than full with the zoölogy.

I had a splendid opportunity to study the wild ass, a mammal new to me and but little known to the scientific world. No museum in America had specimens of the Mongolian species, and I believe there were only one or two skins in England, although the Tibetan species, *Equus hemionus kiang*, was fairly well known. J. H. Miller has given a short account of the wild ass of Dzungaria,[1] and a photograph of a dead specimen as well as of a young living animal which had been domesticated by a Chanto native. The afternoon of our arrival at Loh we saw three wild asses, as I have already described, and I got the first specimen two days later. Just after tiffin, Larsen discovered a fine stallion not more than a mile and a half from camp. He was drowsing in the sun and stood absolutely motionless except for an occasional flick of his tail and lazy movements of his long ears. We watched him through field-glasses for a time and then Larsen, Colgate and I started out in the car.

Profiting by previous experience, we ran almost due south and cut him off from the sandy ground on the lower plain. He seemed to divine our intentions at once and ran for all he was worth toward Baga Bogdo. Colgate stepped on the gas and the motor leaped forward at forty-five miles an hour. The animal could not do better than forty miles, even when straining every muscle to cross in front of us, and that extra five miles was just enough to decide the race. He turned back on the plain and headed straight for the black lava flow a mile to the west.

[1] Carruthers, Douglas. 1914. "Unknown Mongolia," with three chapters on sport, by J. H. Miller. Hutchinson & Co., London. II, pp. 602–608.

It was thrilling when we rushed along within fifty yards of the splendid animal, the first we had seen in action at close quarters. I hated to give the word to stop, but he was dangerously near to the lava, and Colgate jammed on the brakes just as he crossed in front of us. The first volley turned him northward and we leaped back into the car to follow. He had a start of four or five hundred yards but was going perceptibly slower. To add to the excitement, a second ass appeared, seemingly from the air, and galloped parallel with us. It was almost within range, but the first one evidently was in difficulty and I fired again at three hundred yards. He winced, ran a few steps and rolled over, legs waving wildly in the air. We all yelled as he went down. It had been a great race and a new animal had been added to my long list of Asiatic game.

I could hardly wait to examine the specimen. It was a stallion and proved to be the handsomest one we ever killed. The yellow-fawn color of the upper parts shades exquisitely into the pure white of the belly and rump patch. The mane is dark brown and short; from the mane a chocolate-colored band, margined with white, runs to the tail which is tufted and rather mule-like. The ears are longer than those of a Mongol pony but are by no means as large as a donkey's; in fact, the appearance of the animal is like a fine-bodied mule.

In regard to the differences between the Mongolian wild ass and the Tibetan kiang, Miller remarks:

"On comparing one of my specimens with an adult of the Tibetan kiang, *Equus hemionus kiang*, in summer coat, in possession of the British Museum, I found several marked differences, as might be expected from the different environment of the two animals. The kiang is never found below an altitude of 15,000 feet; while the kulon of Mongolia rarely reaches an altitude of 3000 feet, and, at any rate in Dzungaria and portions of Russian Turkestan, is found at an altitude of only 700 feet above sea-level. This accounts for the former carrying a much rougher and more wavy coat than the latter. The general body-color of a kiang is 'rufus' chestnut instead of the pale fawn of the more desert-loving kulon; its dorsal stripe is also less pronounced and without any light margin. But the greatest difference of all is that, in the kiang the whole of the legs are white, while in the kulon they are light sandy fawn, right down to the hoof.

"My specimens are undoubtedly *Equus hemionus typicus*, called by Mongols 'Chigetai' and by Turki people 'kulon.' Its extreme eastern distribution is at present imperfectly known; Sir Francis Younghusband, in his journey across the northern Gobi, mentions seeing kulon in the Gobi at the extreme eastern end of the Altai. They are found north of the Altai Range on the plains, round the large lakes in the Kobdo region; we met with them near Barkul, and in several other places throughout Southern Dzungaria. Westwards they extend throughout Northern Russian Turkestan, being exceedingly numerous

in the neighborhood of Lake Balkash. During the summer they frequent foothills, where the grass does not get so burnt up as on the plains; during the winter they roam all over the steppes, eating snow in place of water. The natives hunt them occasionally for their skins and meat, which they consider more palatable than the best mutton."[1]

SPEED AND ENDURANCE

In the days that followed the killing of our first wild ass, we hunted the animals industriously and soon had obtained all the specimens that were needed for museum purposes. Then we turned our attention to getting still and motion pictures, for this species had never been photographed.

The Mongols told us the most amazing tales of the speed and endurance of the "kulon," and I was anxious to obtain accurate data. One day we discovered a fine stallion well up on the plain near camp. It was in such a position that we could prevent it from reaching either the soft ground to the south or the western lava flow. Shackelford and I spent two hours in the car following the animal, besides exposing one thousand feet of motion-picture film and many still negatives. The ass was very clever in its attempts to reach the sandy ground of the lower plain, but each time we were able to turn it back.

The highest speed that it could reach was forty miles an hour; however, this could be maintained for only a short dash, perhaps two furlongs. Subsequently we found that only a few of the fleetest individuals could reach that speed but that all could do thirty-six miles an hour when galloping full out. Thus there was a difference of four miles an hour between the speed of the slowest and the fastest animals.

To me the most amazing exhibit was the endurance of the wild ass. The stallion which we followed traveled twenty-nine miles before it gave up and lay down. The first sixteen miles were covered at an average speed of thirty miles an hour, as well as could be estimated. During that time there never was a breathing space; it would sometimes slow up to twenty-five miles an hour, when it had evaded us by a sharp turn, but a few moments later would speed up to a rate of forty miles as it tried to cross in front of the car. Once we pounded along fifty feet apart for a considerable distance at thirty-six miles an hour.

After sixteen miles the ass began to slow up perceptibly but kept doggedly at it, averaging almost twenty miles an hour for four miles more. Then he reduced his speed to a slow canter and resorted to more frequent twisting and turning to throw us off his track. Finally the animal stood quietly and Shackelford decided to lasso him. Fortunately, I did not fasten the end of the lariat to the car as Shackelford had suggested, for the instant the rope

[1] *Op. cit.*, II, pp. 607–608.

settled over the animal's neck it lashed out with both hindfeet, badly damaging the radiator, and then started off on a sharp angle at a twenty-five mile an hour sprint.

We had other opportunities later to check our observations as to speed and feel sure that we are correct in saying that forty miles an hour for a short dash is the greatest speed any of the Mongolian wild asses can reach. However, this is considerably better than a wolf can do, for after several runs we were convinced that thirty-six miles an hour is the Mongolian wolf's fastest pace. The wolf is the only natural enemy of the wild ass.

I was greatly interested in the way the wild ass runs. The head is held high and the tail low; the animal is always "collected" like a polo pony and never extends itself as does a race horse, except when putting on its utmost speed in a short dash. Because it is always so well collected it can reach full speed within a very few yards. This, I imagine, is a certain protection from wolves, for their attack would come only as a sudden dash from a ravine or other cover. None of the wild asses which we killed exhibited any indications of having been attacked by wolves, although they often showed scars which were obviously from wounds acquired by fighting among themselves. I witnessed several such battles—the two combatants rising on their hind feet and striking and biting furiously at each other.

All the wild asses which we killed were in splendid condition. There was a thin layer of bright yellow fat under the skin, yet when the animals had had a hard race the sweat was clear, with none of the lather which proclaims a horse to be "out of condition."

FOOD AND WATER

Miller remarks: "During the summer they frequent foothills, where the grass does not get so burnt up as on the plains; during the winter they roam all over the steppes, eating snow in place of water."[1] This, of course, refers to the wild asses of the far west and Dzungaria. In the central Gobi where we encountered them, they were feeding upon the dry desert vegetation such as camel sage, low thorny bushes and stiff bunch grass. This is the same food which the desert gazelles and our camels preferred. We never saw them close to the foothills where there was abundant grass, even during the driest and hottest months of summer; they were invariably to be found well out upon the desert. The only time I have ever seen them eating green vegetation was in 1925, when we explored a narrow valley about one hundred miles in length parallel with the base of the eastern Altai Mountains, just west of Ikhe Bogdo. There was a great concentration of game in this valley, wild asses, both grassland and desert gazelles, and hares. At first we were at a loss to account for

[1] *Op. cit.*, p. 608.

PLATE XXV.

CAMELS IN THE SAND-DUNES NEAR TSAGAN NOR, 1925.

A. PART OF A HERD OF WILD ASSES NEAR ISAGAN NOR

B. WILD ASS RUNNING AT A SPEED OF FORTY MILES AN HOUR, 1025.

it, until we realized that they were all feeding upon a species of wild alfalfa. About the edge of Tsagan Nor, where we camped for several weeks, there was much green grass; at the western end a small river, the Tatsin Gol, runs into the lake, and for a number of miles along the banks there is excellent grazing. Yet, we never saw wild asses in this vicinity, although there were literally thousands of them upon the desert plain only a mile or two away.

Miller's statement that the "kulon" came to various springs to drink and that they eat snow in winter is interesting as differing from our experiences. The water of Tsagan Nor was only slightly brackish, and our camels drank it eagerly, yet we never saw either wild ass or gazelle at the lake nor were their tracks to be found in the marginal mud. I was particularly careful to examine the shore-line for such indications of their presence. At a spring near our camp at Loh there were so many tracks of ponies that we could not distinguish whether or not wild asses came there, although the Mongols said that they did. In the "Grand Canyon," to the west of Loh, there were many of their tracks about the spring.

South of the Altai we explored one of the most barren deserts that I have ever seen. For many miles there was no water except at a few wells along a caravan trail. In this desert we saw a few "kulon," but not many. I attributed their scarcity to lack of food, for there was virtually no vegetation of any sort, rather than to absence of water. It is my belief that wild asses require but very little water; that, as in the case of other desert animals, the starch in the vegetation which they eat is converted by digestive processes into water which is sufficient for their needs. In the Gobi, during the summer, there is almost no rain and little dew; there is no way for the animals to get water in many parts of the desert where they are abundant.

The "kulon" and the desert gazelle live under like conditions in the same regions and are frequently seen together. In fact, if we followed a herd of asses for a few miles in the motor car, gazelles almost invariably came from either side to join in the chase. I feel certain that the gazelles do not require water. In 1925 we found a "kulon" and a gazelle which appeared to be inseparable companions. Day after day we saw them in the same place grazing together, never more than a few yards apart. On the plain at Loh we usually had one or more wild asses in sight from the camp. With the aid of field-glasses I used to watch them throwing dust over themselves, grazing or drowsing peacefully in the sun. Once or twice I saw one lying down.

COLTS

The "kulon" of the central Gobi begin to drop their young during the last week of June, and we saw newly-born young as late as July 10. On July 6, 1922, Shackelford and I caught a baby wild ass which we kept as a pet for six

weeks. The little fellow was not more than three days old and ran beside his mother in a stiff-legged, uncertain manner that was most amusing. He could not go very fast and before long stopped. Shackelford roped him without difficulty and we took him back to camp. He looked like a small woolly donkey. In a short time "Buckshot," one of our Chinese assistants, taught him to drink tinned milk from a canteen, and the little chap appeared to be quite contented with his new diet. A few days later we purchased three goats from a Mongol, but they did not give sufficient milk to satisfy him.

I hoped to be able to bring him back to America for the New York Zoölogical Society, but on August 18 he died. He had lived precariously upon tinned milk and goats' milk, and appeared to be strong although he increased very slowly in size. At the Artsa Bogdo camp in August we got a plentiful supply of cows' milk from the Mongols, but it appeared to be too rich for the baby ass and he died within a few days.

I have never seen such a wild, untamable animal. Even though it was treated with the greatest kindness by all of the men, it never lost its fear except with "Buckshot," who fed and attended it constantly. Whenever anyone else would approach the animal, it dilated its eyes and kicked viciously. Eventually it learned to follow "Buckshot" like a dog and would even enter the cook tent if he happened to be inside. At the end of six weeks, when it died, it appeared to be even more frightened of the rest of us than when it was first captured. I have had many young animals of different kinds as pets but never have I known one to be as untamable as this wild ass.

Possibly this may have been due, to a certain extent, to the fact that the little fellow was a stallion. On June 24, 1925, McKenzie Young and I captured a female which was not more than a day old. This one appeared to be much less frightened and to have a more gentle disposition. Unfortunately, it escaped after two days so that we did not have an opportunity to learn more of the comparative docility of the sex. As it was a cold evening the baby ass had been buttoned up in a leather waistcoat belonging to Lieutenant Robinson and had my police dog's collar about its neck. The rope became loosened during the night and the foal wandered off. Doubtless it died, for certainly no other ass would allow it to approach with the man scent upon the vest.

If I were to try again to bring one back for the Zoölogical Society, I should purchase a pony mare from the natives and teach the little ass to nurse from her, for I am convinced that it never would prosper upon other milk. A Mongol told me that he had reared a wild ass colt which he persuaded a pony mare to adopt. At first the mare would not allow the youngster near her; then the Mongol conceived the idea of pouring some of her own milk over the baby ass and this soon solved the difficulty. The animal flourished but was always wild and difficult to approach, except by its owner. He never was able

to break it to the saddle or use it in any other way. The ponies would not allow it in the herd with them. The Mongol bred it to a pony mare and the resulting mule, although a fine strong animal, could not be ridden.

Mr. F. A. Larsen, who was with us in 1922, is a well-known horse dealer, and had hoped to capture several wild asses for breeding purposes, but after our experience and that of the Mongols, I believe it to be very doubtful whether they would produce usable mules.

Like the desert gazelles, the "kulon" seeks a flat plain upon which to drop its young. They are particularly careful to avoid a region of ravines or gullies which might give cover to wolves. Also like the gazelles, they gather into herds, largely composed of mares, just before the young are born. The stallions do not entirely leave them but remain somewhat separated. Later in the summer many of the males range by themselves. The solitary individuals which we saw were invariably stallions.

The mares evince considerable affection for their young and when we were following a colt in the car the mother would remain close to it, regulating her speed to that of the baby. It was interesting to see how quickly the colts were able to run. Several that we estimated were not more than a week or ten days old could reach a speed of twenty-five miles an hour and maintain it for a mile or two. They tired quickly, of course, but it was by no means easy to capture them, for they could dodge and twist with the greatest agility even though too exhausted to keep up a steady pace. I shot several young for a group in the American Museum of Natural History, but had great difficulty in getting good specimens. The colts were usually badly scarred, as if from bites, and two were suffering from a skin disease like eczema.

The first two weeks of life must be the most critical for them, for then wolves could catch them easily if they were unprotected by their mothers. On the great plain north of Tsagan Nor, however, where two or three thousand wild asses had gathered to foal, I did not see a single wolf, and carcasses were left untouched except by birds. A short distance to the west, across the Tatsin Gol, a small river empties into the Tsagan Nor, where a second great plain exists. It is exactly like the other, but there were few asses upon it and if they were driven away from Tsagan Nor they would drift back in a day or two.

RANGE AND HABITS

The "kulon" seemed to prefer the hard gravel plains and would run into the sandy country only when we approached in the car. They appeared to know instinctively that we could not follow them there and would always make a direct line for soft ground, or into the lava flows which cap part of the region about Loh.

The car had an irresistible attraction for them, as it did for the gazelles,

ponies, camels and all other animals on the plains. When we were running an ass, it would make a supreme effort to cut across in front of us, sometimes missing the car by only a few feet. If there were several hundred asses upon the plain, we needed only to drive up the center to have the animals come in diagonally from both sides, as though drawn by a magnet; after a few miles the whole mass would be thundering along in front of us. Usually such a spectacle was too much for gazelles in the vicinity and they, too, would join the procession.

Miller remarks that the eastward range of the wild ass is unknown. We can give some accurate data upon the subject since we came always from the east. The most eastern record which I have is of a single individual that we encountered just south of the Gurbun Saikhan, of the eastern Altai, in 1925. This is latitude N. 43° 30′, longitude E. 105°, and is six hundred miles from Kalgan. In 1923 we saw a single wild ass near Artsa Bogdo, sixty miles farther west. Thirty or forty miles still farther west they became fairly abundant, and at Tsagan Nor hundreds can usually be found.

As we explored the country for three seasons very carefully, I feel convinced that the Gurbun Saikhan is their easternmost range north of the Altai. South of the Gurbun Saikhan we saw none, although we traveled a long way to the east. Just why the wild ass should so suddenly stop at this point is rather puzzling, for the country to the east for several hundreds of miles is essentially like that of the Tsagan Nor region, with similar climate, vegetation and terrain. Westward, both north and south of the Altai, we saw wild asses, but in no place were they as abundant as on the Tsagan Nor plains.

Miller says that the natives of the west consider that the flesh of the wild ass is "more palatable than the best mutton,"[1] but none of the Mongols whom we saw would eat it. They never hunted the animals nor paid any attention to them except to race one now and then with their ponies for sport.

In Chapter XXVI, I have given an account of a great herd of wild asses which we found in 1925 at Tsagan Nor.

[1] *Loc. cit.*, p. 608.

CHAPTER XI

BIRDS AND ANIMALS OF THE TSAGAN NOR BASIN

TYPICAL DESERT FAUNA AT LOH

During the time that we camped at Loh, my small mammal traps yielded an abundance of specimens, which, however, represented a typical desert fauna much like that of Uskuk. To our surprise, we collected at Loh the first insectivore that we had found in the Gobi. This was a hedgehog, *Erinaceus*, which proved to be abundant on the shores of Tsagan Nor twenty miles away.

Colgate and I poisoned the carcass of a wild ass which we killed on the plain west of camp. For one night it remained untouched, but on the second morning we found near-by two wolves as well as four kites, one golden eagle and a huge black vulture, *Ægypius monachus*. The wolves still wore patches of their long winter fur even though it was June 29. The comparative scarcity of wolves is shown by the fact that we did not get another, and did not even see one, although we poisoned carcasses in widely separated localities. Yet, this region was a favorite breeding-ground for both wild ass and gazelle, and there were hundreds of young animals about. One would have supposed that wolves would congregate there from all the surrounding country. As I have remarked before, I have seen more wolves along the Kalgan-Urga road than anywhere else in Mongolia, except at Wolf Camp in 1930.

BLACK VULTURES

At every poisoned carcass we got several of the great black vultures. This huge bird is one of the most characteristic and interesting sights of the Gobi. One had a wingspread of nine feet six inches. The top of the head is not bare but is covered with short, downlike feathers. The feet are comparatively weak, but the great hooked beak is a most effective weapon. They require space for a run in order to lift themselves into the air, and I saw one which had so gorged itself upon the flesh of a wild ass that it could not get off the ground. When I approached, it settled back upon its tail, striking viciously with its beak. One day I shot a gazelle and left it to follow another wounded buck. When we returned to the dead animal half an hour later a black vulture flew away. We found that during that short time the bird had almost stripped the flesh from one side of the carcass.

In 1925, Doctor Chaney took a young black vulture from a nest at Baga Bogdo and brought it to camp. It flourished and became as tame as a chicken. Eventually I took it back to the New York Zoölogical Park, where it still lives. From the very first we fed this bird upon fresh meat and it absolutely refused to eat carrion of any sort. If meat had the slightest decayed odor it would have nothing to do with it. Viscera seemed particularly distasteful to the vulture and only once or twice did we persuade it to eat a piece of antelope liver, when there was no other meat and the bird had had no food for thirty-six hours.

The bird cared for itself in the most astonishing manner. If we were camped near a lake, it would wade into the water for a bath two or three times a day and then drowse in the sun with wings half spread while drying its feathers. It was always allowed the freedom of the camp and never attempted to get away. In fact, it got distinctly lonely if most of the men were gone and always preferred to be near someone. Its favorite sleeping-place was in the rear of my tent; my police dog also liked to sleep there and the contests for supremacy were most amusing. The dog was usually worsted in these encounters, for he evidently considered it beneath his dignity to fight with a bird.

If we were camped near a spot where there were cliffs, the vulture would spend hours sitting on a projecting pinnacle gazing over the country below. If there were no cliffs, the bird seldom left camp. I was much surprised at the amount of water which it consumed. Drinking by itself from a pail was too slow a process. It much preferred to open its great beak, throw its head back and have someone pour water down its throat. It had considerable intelligence. One day I was sitting in my tent writing. A gasoline tin of drinking water was near the door. The vulture came up to the tin and rapped upon it with its beak, significantly. I paid no attention and after three or four raps the bird entered the tent, jerked my coat and returned to the tin. Of course I gave it water. I could hardly credit the performance but there was no mistake; the vulture knew there was water in the tin and that it could not be had without human assistance. As a matter of fact, it had been given water very often from the tin, which was usually kept at the tent door. During the long trip from China to New York, the bird became very much attached to me and would recognize me instantly even when there were other men about. It was extraordinarily curious and when the men were packing fossils it insisted upon examining every box. Although Mongolia is its summer home, the black vulture goes southward during the winter, and stragglers have been reported even in Fukien Province, near Foochow, south China.

EAGLES AND KITES

At Loh I observed an interesting habit of the golden eagle. We were driving across a perfectly flat plain with two cars. I saw a full-grown golden

eagle crouching behind a small bush with its head stretched out. After we passed, it half rose to its feet, and then it saw the second car. It sank back again and remained motionless until the motor had passed, when it flew away. We observed this same trick by other individuals at two other times during the summer.

The kites were a never-ending source of amusement to us at camp. Thirty or forty of them were usually sitting on the ground or flying about the tents. As soon as one would pick up something and attempt to fly away, the others would attack it like a pack of wolves. One day when there were a great number about we threw out a dozen bits of meat. The kites sat in a row a few yards away for more than an hour. Each time one made an attempt to get a bit of food the others flew at it. As a result none of them got any of the meat, although they all wanted it.

A FOURTH OF JULY IN THE DESERT

The Fourth of July at Loh was unforgetable because of the mirage. It was the first day of real heat, the temperature rising to 95° F. in the shade, and absolutely windless. The desert swam in heat waves. If a man walked a hundred yards away from the tents he seemed to be wading in water up to his knees. Everything was so distorted that it seemed as if we were living in an unreal world. In the afternoon we were treated to another unusual sight. The whole shimmering plain became alive with "wind devils," small whirling clouds which sucked the sand and dust into the air perhaps one hundred feet high and danced away at race-horse speed. One of them struck our camp squarely in the middle; socks, trousers and shirts which were drying on a line were drawn up into the air and scattered over the plain. The wind devil passed in thirty seconds but it nearly wrecked our tents. Once I raced a large whirlwind in the car and found that it traveled faster than thirty-five miles an hour, which was the best speed I could make on the rather rough terrain. I estimated that it was moving at about forty-two miles an hour.

A TRIP TO URGA

On July 3, I sent Colgate, with Larsen and Badmajapoff, to Urga with one car. Larsen and Badmajapoff had to return to their business interests, and I was particularly anxious to get news of what was happening in China, for a sizable war had started just as we left. I disliked to send a single car on an eight-hundred-mile trip, but we knew that the traveling was good most of the way, and Colgate felt confident that he would have no difficulty. As a matter of fact, he made the trip in just twelve days, including four and a half days spent in Urga.

ON THE SHORE OF TSAGAN NOR

Shackelford and I had made several attempts to reach Tsagan Nor, the lake which we could see gleaming whitely twenty miles to the south. Each time it had been impossible to go very far because of the soft sandy ground, but on July 6, we had better success. Much to our surprise we were able to run quite easily over the southern flat, and then we realized that all our earlier attempts had been made a day or two after rain when the ground was still soft. When it had been baked by the sun there was sufficient crust to hold up a light car. Half-way to the lake we came upon another fine hard plain, which swarmed with wild asses and antelopes. At the western end of Tsagan Nor, where a small stream, the Tatsin Gol, empties into the lake, there was a wide valley carpeted with green grass. There fifteen yurts had been pitched along the base of the bordering sandy hillocks, and the Mongol inhabitants rushed out to wave us a greeting. They were not frightened of the cars, as they had known of our presence since the first day that we arrived at Wild Ass Camp.

The lake proved to be a lovely spot. Coarse green grass margined the water, and Baga Bogdo was reflected in its calm surface. Hundreds of ducks, geese, sheldrakes and grebes were paddling about, followed by trailing wakes of downy young. Between the lake and the mountain south of it there was a long line of cream-white sand-dunes, beautifully sculptured by the wind.

We were both so enchanted by the lake that we decided to move our part of the camp there at once. The geologists had arrived from Uskuk, having reached Loh in the southward extension of their geological and topographical map. They had found the region to be even more interesting from a structural standpoint than they had at first supposed and were keen to carry their work over to Baga Bogdo. Granger thought it best to remain at Loh for further palæontological work. After I had made a trip back to the caravan for supplies and instructed them to join us at the lake, the rest of us were free to move.

Shackelford and I went down on July 11 and camped on the gravel beach not fifty yards from the water's edge. Short grass and weeds gave it quite a lawn-like effect. Neither of us has ever forgotten that first evening. Just as the sun disappeared, Baga Bogdo was flooded with a wonderful lavender light which edged the lake with deepest purple; then the moon rose from behind the sand-dunes in a splendor of gold, drawing a glittering path across the water to the very door of our tent.

FAUNA AT TSAGAN NOR

In the marsh-grass and rank vegetation beside the lake, a green insect, like a large mosquito, swarmed in countless thousands. Just at dark these began to rise with a hum like distant motors. The noise was quite appalling

and we thought that we should be forced to leave, but fortunately the insect is exclusively a vegetable feeder and did not annoy us in the slightest. They formed a stratum three feet thick and seemed to be following the lake shore from west to east. The flight line lay four feet above the ground, and below that level there was hardly an insect. Not many came into the tents when the candles were lighted, and there were no mosquitoes or sand flies; in fact, it was an ideal summer resort.

Of course we were curious to know whether or not there were fish in the lake. The first evening we saw a number of suspicious-looking swirls in the water which we were certain must be made by fish. Hooks and lines gave us nothing, but I had a twenty-foot seine which yielded a plentiful supply of minnows. They were all of a single species, *Oreoleuciscus pewzowi*, and few of them were more than eight or ten inches in length. Mr. J. T. Nichols, 1930, who has identified the fish, says that their affinities are to species of the far western Altai Mountains. How these small inland lakes became stocked with fish remains a mystery. The supposition that the eggs or the fish themselves were carried from one lake to another by birds does not appear entirely satisfactory in a region where the bodies of water are so widely separated as in the Gobi. There are gulls, terns, ducks, geese and sheldrakes on almost all of the lakes, but in Orok Nor and Kholobolchi Nor, two lakes only thirty miles from Tsagan Nor, the fish of the first two named lakes were unlike those of the last. It seems more probable that at some time in the past there has been a drainage into the lake of small streams which have disappeared. As we know that some, at least, of the smaller lakes which now contain fish have been dry for one or two years during certain intervals, it is evident that the fish must be capable of living buried in the mud for long periods. The problem is one which requires more study.

At Tsagan Nor, and in fact all through the desert, two species of lizards were abundant. These have been identified by Mr. Karl P. Schmidt, 1927, as *Phrynocephalus versicolor* and *Eremias przewalskii*, the former ranging south into northern Shansi and being much more numerous than the latter. Except for these two species we saw no lizards in the Gobi.

In the coarse grass at the western end of Tsagan Nor, where the Tatsin Gol flowed into the lake, mallard ducks, ruddy sheldrakes and bar-headed geese had nested, and their young were about one-third grown. The birds soon became accustomed to our presence, since we did no shooting near camp, and would bring their broods close into shore when the wind blew the feed toward our side of the lake. Shackelford got many photographs of the birds from his tent.

One day in late July I discerned a pair of geese which I could not identify, and shot one. It proved to be the graylag, *Anser anser*, and a few weeks later

we saw several flocks of the same species some miles to the eastward. I have not seen this goose at other localities in Mongolia and conclude that it is not abundant there. In north China it is only an occasional visitor.

Our traps yielded many small mammals, among which the two sand rats, *Meriones auceps* and *M. unguiculatus*, were in greatest abundance. Although the two species are much alike in appearance and live side by side, the former is strictly nocturnal while the latter is almost entirely diurnal. In a dry stream-bed at the "Grand Canyon," ten miles north of the lake, Granger discovered a colony of giant sand rats which proved to represent *Rhombomys opimus nigrescens*. We had previously obtained a single specimen at Iren Dabasu, which extends the range well to the east. The animals live in colonies like the smaller gerbils, burrowing in the sand hummocks. This species appears to be entirely diurnal.

One night at Tsagan Nor, a very small brown shrew, the only one we saw in the desert, was caught in the taxidermists' tent. Dr. G. M. Allen, 1928, has described it as a new species, *Crocidura lar*, and remarks that the genus is thus extended in its northward range in this part of Asia. It certainly made a mistake in choosing the taxidermists' tent for its investigations!

The hedgehog was the only other insectivore that we caught in the Gobi. These animals were abundant in the long grass near the water's edge. We would throw a piece of antelope meat into the grass and shortly after dark visit it with a flashlight. Usually we could discover one or more hedgehogs in the vicinity and could catch them without much difficulty. The older individuals were not easily tamed, but one half-grown male became as gentle as a kitten. In fact, Mr. Shackelford kept this little fellow as a pet all through the summer and eventually took it to New York with him. After living for some time in his apartment it was transferred to the New York Zoölogical Park. It ate grasshoppers and other insects and bits of fresh meat voraciously and was particularly fond of big black beetles. After a few days it could be handled with impunity. Only when angry or suddenly startled would it erect its quills. Surprisingly enough, it seemed to require a good deal of water and would lap it up from a shallow plate like a dog. When we returned to Peking in the autumn, by mistake one night the hedgehog was placed in a box containing a young and active alligator, *Alligator sinense*, about eighteen inches long. In the morning the alligator was dead. The hedgehog had almost entirely devoured the right hind leg and had eaten a large hole into the abdominal cavity.

One day at Tsagan Nor I shot a fox, *Vulpes vulpes karagan*, a pale straw-yellow animal such as one would expect to find in the desert. I was stalking a flock of ducks, which were swimming near the reed-grown shore, and discovered the fox engaged in the same pursuit.

PLATE XXVIII.

PUSHING ONE OF THE EXPEDITION CARS THROUGH SAND.

Strips of canvas, reinforced with transverse pieces of rope, were often placed in front of the wheels.

PLATE XXIX.

A. WILD ASS RUNNING AT FULL SPEED, TSAGAN NOR, 1025.

B. HEAD OF GOITERED GAZELLE, *Procapra gutturosa.*

C. HEAD OF DESERT GAZELLE. *Gazella subgutturosa hillieriana.*

D. HEAD OF MONGOLIAN BLACK VULTURE.

DESERT GAZELLES

On the gravel plain north of the lake, gazelles, *Gazella subgutturosa hillieriana*, were very abundant. The great flat plain was an ideal place for the does to rear their young. When we reached there on July 11, most of the baby antelope were two or three weeks old and were running with their mothers. The does begin to drop their young about June 15; we saw no newly-born fawns after July 10. Virtually all the does were in milk. A single young is usual, but twins are not infrequent.

The grassland gazelle, *Procapra gutturosa*, gathers into great herds of does in the spring just before the young are born and again into mixed herds in the autumn. The desert gazelle never does this. I believe the reason is that at no spot in the desert is there sufficient vegetation to support a large, slowly moving herd; in the grasslands there is ample feed.

On the Tsagan Nor plain the gazelles were in groups of from half a dozen to thirty or forty, all bucks; the females usually were alone or in couples, each with its fawn. Only once or twice during the summer did we see bucks and does together. The fawns were very clever at hiding. They would lie flat upon the ground beside a sage bush only a few inches high, with their ears dropped and neck stretched out. Many times I have tried to creep up and throw a coat over one, but just before I was within reach it would dash away. The brown woolly hair was so exactly the color of the desert gravel that the little fellows were almost invisible when motionless. I usually discovered them by their brilliant eyes.

The fawns hide until they are about two weeks old; then they prefer to trust to their legs and speed. Nevertheless, they can run at a very respectable rate within a few hours of birth. One which was not yet dry behind the ears tired out my pony in a chase; although the fawn could not run as fast as the pony, by rapid turns it would gain so much distance that I could not catch it.

We followed a fawn on June 27 in the motor car. It was about ten days old and was with its mother. When we first discovered them, the female tried to entice us away, but we stuck close upon the heels of the fawn. For the first four miles it averaged twenty-five an hour, but soon tired after that and resorted to dodging to elude us; it ran a total of nine miles before we finally caught it. After the first three weeks a wolf could not equal the speed of a baby antelope. We did not find any wolves that could exceed thirty-six miles an hour even on the first dash, and the fawns could reach forty miles an hour without half trying.

We have demonstrated beyond a doubt, with our cars, that the desert gazelle can reach a speed of sixty miles an hour in its initial dash. It can maintain this speed for only about half a mile; then it will drop to forty or forty-five miles an hour. The grassland species, which is larger and has a

heavier body and proportionately shorter legs, cannot reach a greater speed than forty-five or fifty miles an hour. We followed one desert gazelle, a fine buck, for ten miles. We were on a flat plain where the going was excellent for the car. He left us easily in the first three miles and we could just keep his bobbing white rump patch in sight; then he settled down to a steady pace of thirty miles an hour, keeping about one hundred yards in front of the car. He continued at this speed for seven miles until we punctured a tire. During the last two miles his tongue was hanging out, but I am sure that he could have run five or six miles more.

When the gazelles first start off they often progress in a series of stiff-legged bounds, which make them appear to be on springs, but when they reach high speed they settle into a smooth even run and seldom bound. They will not go faster than is necessary to keep about two hundred yards in front of whatever is following them, and it is only when thoroughly frightened that they will extend themselves. They always try to cross in front of a pursuer.

Of course, the ability to reach such a high speed in the initial dash is a protection from wolves, their only important natural enemy. Wolves can hope to catch an antelope only by lying in wait behind some cover until it is near enough for a surprise attack. The gazelles' safeguards are being able to "get away" like a flash and leap into high speed instantly.

Eagles are the principal enemy of the baby gazelles, and they must get a good many adults too. About an eagle's nest at Ardyn Obo I found the remains of at least twenty antelopes, some of them being full-grown bucks. Miller says that in the western Gobi, the Kirghiz, and occasionally the Chantos, hunt gazelles by means of trained golden eagles, but, in the regions which we visited, the Mongols did not indulge in this sport.

Gazelles have amazing vitality and even when badly shot can continue to run. With a broken foreleg the animal can easily reach thirty-five miles an hour; a shattered hind leg slows it up considerably but it can still do fifteen miles an hour for some distance. Although the grassland species sometimes wanders into the edge of the desert, I never have seen the desert gazelle in the grasslands. Like camels and wild asses it prefers the dry, hard vegetation of the desert to the most succulent grass. Miller says that the grassland species is found all over northwestern Mongolia, north of the Great Altai, and south of the Tannu Ola ranges. He puts their extreme northwesterly limit as Kash-Agatch and remarks that in the summer they ascend right up into the mountains where he hunted *Ovis ammon*. He mistakenly considers Russian Turkestan and western Asia to be the centers of distribution of the desert gazelle.

CHAPTER XII

MONGOLS AND THEIR RECENT POLITICAL HISTORY

A MONGOL ENCAMPMENT AT TSAGAN NOR

IMMEDIATELY upon our arrival at Tsagan Nor we made friends with the Mongols who were encamped at the western end of the lake. They were cordial as usual and we saw an opportunity for Shackelford to photograph a good film story of native life. The yurts were arranged in three groups along the gravel base of the lake depression, at the edge of a green meadow formed by springs from the Tatsin Gol.

A lama about fifty years old appeared to be the head man of the village, and we were invited for tea in his yurt upon our first call at the encampment. His religious vows had not prevented him from "taking unto himself a wife" and he had a thriving family. One of his daughters, an attractive girl of eighteen, shyly approached me holding up a bandaged hand for inspection. I found that a finger had been badly injured and was a mass of gangrene. Subsequently I treated the finger with such good results that the family became our firm friends and we could do as we pleased in the village.

INSIDE A MONGOL YURT

The lama was well-to-do and owned large herds of sheep, goats and camels. Nevertheless, his yurt varied in few particulars from those of the other less opulent members of the community. Several red chests, and beside them a small altar bearing a picture of Buddha, stood at the back; on the right side was a low bed platform six inches off the ground; near the door, on the right, a rack of milk-pans and several old skins upon which half a dozen very young lambs and goats were lying. The seat of honor is at the back of the yurt, facing the door. Yurts vary little in their interior arrangements, but some of the richer men keep a special reception yurt, in which young animals are not allowed.

MONGOL FOOD

In the center of every yurt an argul fire burns, and over it the family cooking is done in a great iron bowl. Tea and milk are boiled together, ladled

out into tall cylindrical brass-bound pitchers and passed about to be poured into the small wooden eating bowl which every Mongol carries in his, or her, gown. As often as it is available, mutton or other meat is boiled in the great pot, and eaten with the fingers and the aid of a sheath knife.

The Mongols of the desert appear to keep cattle only for their milk, or to sell. I have not happened to see one kill a steer for meat, but I am told that they do eat beef to a large extent in the grasslands where cattle are more numerous. Mutton is their favorite food. They prefer it to any other kind of meat. Our caravan Mongols, who of course were somewhat spoiled, refused to eat antelope because they thought that by refusing antelope, they would get more mutton. They stoutly maintained that they did not like antelope meat; but other natives were delighted to get it. The mutton is good except where the sheep have been eating the small wild onion which grows abundantly everywhere on the desert. Then the flavor is decidedly "oniony," but the Mongols consider that as a distinct asset. I have never seen the Mongols prepare meat in any other way than by boiling. Since they are a pastoral people they have almost nothing to eat except animal products. Butter, cheese, milk, meat and tea are their ordinary food. Now and then they obtain a little flour from the Chinese traders and make a kind of bread fried in grease, but the poorer natives cannot afford to indulge in such luxuries.

The Chahar and other Mongols who live in Inner Mongolia, where they are in closer touch with the Chinese and an agricultural region, use a great deal of flour and other vegetable foods such as potatoes and millet. On the slopes of the Altai Mountains we found a few wild onions and rhubarb. The latter the natives use only as a medicine, but the onions they eat raw. In the spring I have seen them eat the pods of young milkweed and in the autumn the fruit of the dune berry, *Nitraria schoberi*.

One might suppose that such an exclusively animal diet would be unhealthful. Such is not the case. During the long, extremely cold winter they must have heating food and, like the Eskimo, the Mongol requires meat and much fat.

MONGOL FLOCKS AND HERDS

The entire life of the Mongols is the product of their environment, which is and has been dependent upon climate and geography. The country is too dry, cold and windy for agriculture, except in the southern grasslands. Conditions forced them to become a pastoral people, and nomadic. They depend entirely upon their flocks and herds for the necessities of existence. Their independence, love of sport, hospitality and admiration for the strenuous elements of life are a direct result of the conditions under which they live.

In the real desert, sheep, goats and camels are the only animals that can

exist in numbers upon the sparse, dry vegetation. In the grasslands, ponies and cattle are to be seen in considerable herds. The sheep and goats are gathered at the yurt at about ten o'clock in the morning for milking; then they are driven to the grazing grounds where they remain until dark, when they are again brought back for the night. Women and children do most of the herding. I have seen kiddies not more than five or six years old tending a flock of sheep in a most efficient way.

A Mongol's wealth is always estimated by the number of animals which he possesses. Even the poorest natives own at least one pony and a few sheep or goats. During all my years in Mongolia, I have seen only one beggar on the plains, and he rode a very decent pony! Before the Russian Soviet Government assumed control of Outer Mongolia, the princes had herds of ponies, camels, sheep and goats, numbering many thousands. Cattle are comparatively few.

Although Mongols are necessarily nomads, they move only within certain prescribed limits. At a meeting of the inhabitants of a district with their officials in the early spring, grazing grounds are allotted to each family or village. They must adhere rigidly to these allotments. How many times they move depends entirely upon the grass. If mountains are near-by the Mongols go well up into the valleys during the summer, where there is better grass and water. In the winter they return to the plains. There are many parts of the desert where grazing is fairly good but where water is not to be had. Usually the natives go there in the winter, depending upon snow for water. They cannot remain in the mountain valleys during the winter, for the snow lies so deep that their stock would be unable to dig down to the grass beneath it. On the plains the high winds sweep large areas bare, piling the snow into drifts.

Since animal droppings (argul) are the only fuel and these burn rapidly, a considerable quantity is accumulated for winter use. Sheep dung is made into large bricks during the summer, and these are frequently piled about the yurt as a wall. This acts as a windbreak for the dwelling, a corral for the animals and a fuel supply. If a family moves away from such a place in the spring, leaving a quantity of unused argul, other Mongols do not take it, as they know the owners will return.

THE MONGOL ON HORSEBACK

A Mongol's real home is the back of a pony. He is uncomfortable on the ground. His great boots are not adapted for walking and he is so seldom on foot that to walk a mile is punishment. To go only a hundred yards or so he will jump on his pony, which always stands hobbled within reach. Children learn to ride in infancy. Each year, in the spring, a juvenile race was formerly held at Urga. Boys and girls from four to six years old were tied on ponies

and rode at full speed over a mile-long course. If a child fell off, it received but little sympathy, and was strapped on again more tightly than before. A Mongol has no respect whatever for a man or woman who cannot ride, and nothing will win his admiration so quickly as good horsemanship. Mongols usually ride either at a trot or a full gallop. They use a broken snaffle bit and ride with a loose rein, always swinging the whip, which is a short stick with a lash at the end.

SPORTS OF THE MONGOLS

Ponies are fairly cheap in Mongolia, but not extraordinarily so. Racing is almost a business and if a native owns a fast pony he is a lucky man. He goes to the annual field meets at all the temples in his neighborhood and will race for a sheep or a goat in the interim, or just for sport. The races are really endurance contests. Five to ten miles is the usual distance and I have known some races to cover twenty miles. The ponies are ridden by boys twelve or fourteen years old, who beat their mounts from start to finish.

Next to horsemanship, the ability to shoot is most admired by a Mongol. Almost every native possesses a flintlock gun with an enormously long barrel. Its effective distance is hardly a hundred yards and they seldom shoot even at that range. They do not shoot offhand. Mr. Larsen speaks of the ability of a Mongol to shoot from a galloping horse, but I never have seen one even attempt it. Two long sticks are attached to the barrel on either side and these are used as a rest. When carrying the gun the sticks are folded back on either side of the stock. The Mongols never ceased to talk about the ability of our men to shoot running antelope offhand at three or four hundred yards.

AN ANNUAL FIELD MEET

Every year the natives of each district in Mongolia hold a field meet. Usually these are at temples; sometimes at obos. Horse-racing, wrestling, shooting and rarely archery contests are the order of the day. Mongols gather from long distances, dressed in their finest clothes, and sometimes remain for a week or more.

In 1919 I described a field meet in the forests north of Urga. The description may well be quoted here as a typical example of a small meet:

"The Terelche Valley meet was held on a flat strip of ground just below our camp. As my wife and I rode out of the forest, a dozen Mongols swept by, gorgeous in flaming red and streaming peacock plumes. They waved a challenge to us and we joined them in a wild race to a flag in the center of the field. On the side of the hill sat a row of lamas in dazzling yellow gowns; opposite them were the judges, among whom I recognized Tserin Dorchy, though he was so bedecked, behatted and beribboned that I could hardly realize that it

PLATE XXX.

A. A FRAMEWORK OF A YURT AS IT IS BEING ERECTED.

B. YURT AND CORRAL FOR LAMBS, KIDS AND CALVES.

A. WOMEN OF THE CHAHAR DISTRICT, SOUTHERN MONGOLIA.

B. INTERIOR OF A YURT.

was the same old fellow with whom we had lived in camp. (I presume if he saw me in the clothes of civilization he would be equally surprised.)

"In front of the judges, who represented the most respected laity of the community, were bowls of cheese cut into tiny cubes. The spectators consisted of two groups of women who sat some distance apart in compact masses, the 'horns' of their headdresses almost interlocked. Their costumes were marvels of brilliance. They looked like a flock of gorgeous butterflies which had alighted for a moment on the grass.

"The first race consisted of about a dozen ponies, ridden by fourteen-year-old boys and girls. They swept up the valley from the starting point in full run, hair streaming and uttering wild yells. The winner was led by two old Mongols to the row of lamas, before whom he prostrated himself twice and received a handful of cheese. This he scattered broadcast as he was conducted ceremoniously to the judges, from whom he returned with palms brimming with bits of cheese.

"Finally, all the contestants in the races, and half a dozen of the Mongols on horseback, lined up in front of the priests, each one singing a barbaric chant. Then they circled about the lamas, beating their horses until they were in full run.

"After the race came wrestling matches. The contestants sparred for holds and when finally clinched, each with a grip on the other's waistband, endeavored to obtain a fall by suddenly heaving. When the last wrestling match was finished, a tall Mongol raised the yellow banner and, followed by every man and boy on horseback, circled about the seated lamas. Faster and faster they rode, yelling like demons, and then strung off across the valley to the nearest yurt.

"This love of sport is one of the most attractive characteristics of the Mongols. It is common ground on which a foreigner immediately has a point of contact. The Chinese, on the contrary, despise all forms of physical exercise. They consider it 'bad form' and cannot understand sport which calls for violent physical exertion. They prefer quiet walks carrying their pet birds in cages for an airing; to play a game of cards; or, if they must travel, to loll back in a sedan chair with the curtains drawn and every breath of air excluded."[1]

MONGOL CHARACTERISTICS

The Mongols are a strong race. Their country itself is exceedingly healthy, and with ordinary attention to hygiene there would be little illness, but they are so ignorant and uncleanly that certain diseases are common. I have discussed this subject more fully in Chapter XXXII.

[1] Andrews, Roy Chapman. 1921. "Across Mongolian Plains." D. Appleton & Co., New York. Pp. 158–159.

One seldom sees sick Mongols. I suppose one of the reasons is that if a person is very ill the relatives simply decamp and leave the invalid to die. Believing that evil spirits take possession of a body as soon as life is extinct, they are extremely loath to have anyone die in their yurt. I have often seen the mute evidences of a desert tragedy—a skeleton lying beside the dead ashes of a fire; near-by a wooden bowl with a little food; there, the circular mark left by the yurt. The story was plainly told. The person was about to die and the other members of the family had moved to new grazing grounds, leaving the invalid to pass the last moment of his life alone in the desert.

The Mongols are very superstitious about human remains. Under no circumstances will they touch or disturb a skull or skeleton. As soon as a person dies the body is dragged off to a considerable distance and left to be devoured by the dogs, wolves and birds. Sometimes the corpse is placed upon a cart which is drawn rapidly over rough ground. At some point the body falls off. The driver does not look back for fear that he will be followed by the evil spirits of the dead. At Urga there are several places not far from the city where corpses are left to be devoured by the dogs, and I managed to obtain a fine series of skulls for anthropological study.

Venereal disease is difficult to check because of the promiscuous habits of the Mongols. They are unmoral rather than immoral; they live like untaught children of nature, and modesty, as we conceive it, does not enter into their scheme of life. Adultery is openly practiced, apparently without prejudice to either party, and chastity is not a virtue. Traveling lamas very frequently demand a woman when they stop for a night in a yurt and they are seldom refused.

Life in the desert and on the plains of Mongolia is much like that of our own west in the pioneer days. Similar environment has developed similar customs. As in western America, hospitality is a law in Mongolia; assistance to a traveler is taken as a matter of course.

MONGOL HOSPITALITY

When one comes to a Mongol yurt, he enters, sits down beside the fire feeling sure of his welcome and is helped from the common pot. He may stay a day or several days without thought of payment. Every Mongol knows that he himself will ask for hospitality many times during the year and thus he is ready to offer what he has to other travelers.

I have often had Mongols ride several miles to bring my ponies to camp or tell me in which direction they had strayed; they would expect as much themselves in similar circumstances. To be left without a pony is a serious matter, for the distance between wells in the desert is often great. Horse stealing is a capital crime. In the days before the Soviet dominance, if a Mongol reported

that a pony had been stolen, soldiers took up the trail and followed it until they ran the thief to earth; usually he was shot at once.

MONGOL DOGS

Next to ponies, dogs are probably the Mongol's most valued possession. The large Tibetan mastiff is the usual breed but smaller mongrel dogs are found everywhere. All are exceedingly savage. They make excellent watch-dogs for yurt or caravan and are trained to attack on sight. It is dangerous to approach a yurt unarmed. In Urga the dogs eat human remains and are fed by the lamas. It is a crime to kill a dog. I have never seen a dog inside a yurt. The owners do not pet them, for savageness is a virtue.

I have had several very narrow escapes from being killed and eaten by Mongol dogs, for when they are hungry they will attack a man like wolves. If one dog of a pack is injured and yelps, the others will tear it into pieces instantly. Doctor Berkey was attacked and probably would have been killed had he not shot the dog; almost all the men of the Expedition had more or less narrow escapes.

HOW NEWS TRAVELS IN MONGOLIA

Every newcomer in Mongolia is impressed by the rapidity with which news travels great distances; it is often believed to be due to some telepathic method of communication which has been developed by the natives. It is true that news does travel in an amazing way, but I believe that the explanation is quite simple.

The wells all over Mongolia are the natural meeting places and concentration points. Here the Mongols gather to water their stock and to gossip. If a traveler is near a well he will always ride over to see who is there and to hear the news. There is little to talk about and the slightest novelty is discussed and rediscussed for hours. Very often a Mongol will ride forty or fifty miles to carry news to some of his friends; these in turn send it on to other yurts. A fifty-mile ride is nothing to a Mongol. He knows that he always will find a welcome at any yurt. He seldom has business of such importance that it cannot wait a few days while he disperses a choice bit of gossip.

THE MONGOLS' SENSE OF DIRECTION

The Mongols have a direction sense which is most amazing. I often have been hunting gazelle on plains where there seemed nothing to serve as a landmark. I might drop an animal and leave it for an hour or so. With a quick glance around my Mongol would fix the spot in his mind and dash off on a chase which might carry us back and forth toward every point of the compass. When it was time to return he would take us back unerringly to that single

spot on the open plain. Of course, I learned to note the position of the sun, the character of the ground and the direction of the wind, but only by years of training can a white man hope even to approximate the Mongols' skill. They have been born and reared upon the plains and have the inheritance of unknown generations whose life depended upon their ability to come and go at will. To them the hills, the sun, the grass, the sand—all have become the street signs of the desert.

MONGOL AND CHINESE ATTITUDES CONTRASTED

This wild free life of the plains has made the Mongol exceedingly independent. He relies entirely upon himself, for he has learned that in the struggle for existence it is he himself that counts. Of the Chinese the opposite is true. His life is one of the community and he depends upon his family and his village. He is gregarious above all else and he hates to live alone. In this dependence upon his fellow men he knows that money counts—and there is very little that a Chinese will not do for money. We found that the personal equation enters very largely into any dealings with a Mongol. If he likes you, remuneration is an incident. If you do not appeal to him, money tempts him but little.

Although the Mongols are lazy under ordinary circumstances, they are not always so. Laziness is largely a product of their pastoral pursuits. Herding sheep and goats requires little exertion, but at certain times their life demands extreme exertion and then the energy and endurance which they display are amazing. I believe that the Mongol of to-day is quite equal to the warrior of Genghis Khan's time, as far as hardihood and endurance are concerned. Moreover, the present-day Mongol is an excellent fighter, as recent events have shown.

In no part of the country which I have visited did the Mongols make any attempt at agriculture, but I have been told that a little farming is done in certain places in western and southern Mongolia. They sell a good deal of wool to Chinese traders, and until 1926 the International Export Company bought many thousands of sheep to be driven alive to Kweihwating or Hailar, where they were killed and packed for shipment abroad.

SHEEP-SHEARING AND FELT-MAKING

The Mongols barter with the Chinese for those simple necessities of life which they themselves do not produce. Sheep and goats give them almost all they need. In the winter they dress almost entirely in sheepskins, but their summer garments are of cloth. From the Chinese they buy cloth, boots, tea and tobacco. The only things that I have seen them manufacture are felt and silverware.

PLATE XXXII.

A. MONGOLS MAKING FELT, TSAGAN NOR, 1922.

B. MONGOLS MILKING GOATS.

The goats are held in line by a long rope which is looped around the neck of each animal.

A. ANDREWS DRESSING AN INJURY TO A MONGOL GIRL, TSAGAN NOR, 1922.

B. TYPICAL MONGOL NOMADS, SHABARAKH USU, 1925.

Felt-making is a rather interesting process and Shackelford photographed operations at Tsagan Nor. The sheep to be sheared were tied nose to nose on a long rope. Then one by one they were thrown and the wool roughly cut off with huge iron shears. Meanwhile two men were twisting the wool in loose ropes. Then it was taken to a flat plain above the yurts where a large strip of cloth had been spread upon the ground. Two old women spread a thick layer of wool upon the cloth and thoroughly soaked it with whey left from cheese-making, afterward spreading another strip upon it. This "wool sandwich" was rolled on a long pole, wrapped in a thin cloth and tightly bound. Ropes were fastened to the projecting ends of the pole, and a Mongol mounted on a camel dragged the cylinder behind him over a smooth path for several hours. Then it was again wet with whey and rolled. When the cylinder was finally opened the wool had been firmly pressed into a thick strip of felt. All that remained was to dry it in the sun and sew the edges with twine to prevent fraying.

MONGOL WOMEN AND CHILDREN

The Mongol women have a great deal more independence than those of China, but share in the work of herding the stock as well as attending to the domestic duties of cooking, making cheese and butter, and caring for the yurt. The children, as I have remarked, are put to work almost as soon as they can walk and pursue their business of herding goats and sheep in a most serious manner. The Mongols appear to have a good deal of affection for the children and take much pride in their ability to ride, wrestle or shoot.

MONGOL MANNERS

The men universally use snuff. When a Mongol comes into camp or sits down beside the fire in a yurt, his first proceeding is to pass his snuff bottle to each person. It is exceedingly impolite to refuse to accept it, but it is not necessary to actually take the snuff. One can take the bottle in both hands, put it to one's nose and pass it on to one's neighbor. If the visit is an official one, or a favor is about to be asked, the visitor usually produces a light blue strip of silk, called a *hata*, which is spread out and presented on outspread hands.

The abrupt way in which Mongols enter a tent or yurt is rather disconcerting at first. There is no preliminary knocking or asking permission; they simply come in and sit down. They invariably leave with the owner if he goes out. In Urga it was always difficult for foreign women to accustom themselves to this habit. A Mongol will enter a house as unceremoniously as though it were a yurt on the plains, and make his way about even into the bedroom without a word of warning.

When a gift is presented to a Mongol, even if he is greatly pleased with it, he simply accepts it stoically without a sign of appreciation. I have sometimes seen one put up a thumb, as do the natives all over the Orient, and say *sai* (good), but this is only when they are exceedingly pleased. Still they are not unappreciative and undoubtedly do have a sense of gratitude. It is merely a custom of the country.

THE PASTORAL LIFE OF THE MONGOLS

Since the Mongols are essentially nomadic they have developed no arts or manufactories. They can stay in one spot only as long as the grazing lasts. They must not hamper themselves with unnecessary household goods, or it would be too difficult to move. Even though, under Genghis and Kublai Khan, they conquered half the then-known world, they left nothing constructive behind them. They had nothing to give. At that time theirs was the same pastoral existence that it is to-day. Culture, art, architecture, did not enter into their lives. These could not be developed in a nomadic people living a wild, restless life upon the plains and deserts, with the struggle for existence against the forces of nature ever present in their minds.

If a Mongol of Genghis Khan's time should suddenly drop into the middle of Mongolia to-day, he would be perfectly at home. He would find that the everyday business of life, except in a few minor particulars, is carried on almost the same as in his day seven hundred years ago. There has been no reason to change the fundamentals of existence. The environment is very much the same. It is still a pastoral life.

LAMAISM AND THE DECLINE OF THE MONGOL RACE

The only thing that has altered radically in the Mongol race is the spirit of the people and their religion. A Mongol of Genghis Khan's time would find them no longer a race of warriors. He would find that two thirds, at least, of the male population had donned the yellow and red robes of lamas; that they had become dissolute human parasites. It would be difficult for him to adjust his mental perspective to such a state. It is totally incongruous to a people who live upon the plains and deserts combating the forces of nature for their very existence.

There were several contributing causes to the decay of the Mongol race, but the primal factor was the introduction of lamaism about 1290. Before this they had been Shamanists, worshiping the spirits of nature that lived in the rocks and trees and mountains. Lamaism became the religion of the state. Its teachings are against war, learning, enterprise, ambition. Fostered by the Chinese, who realized its value in subjugating a warlike race, it obtained such a powerful hold over the superstitious nomads that it became the paramount

factor in their lives. The authority of chieftains and generals gave way to that of Buddhist priests.

Custom decreed that the first-born son of every family should become a lama. Sometimes all the male children joined the priesthood. Many of them remained permanently in the temples which had sprung up over all the country. Those who returned to their yurts had learned habits of slothfulness and were periodically at the call of the ruling lamas of their district. Were one to enter fully into a discussion of the evil effects of this religion, he could trace to that source virtually all the major factors in the disintegration of this virile, once-glorious race. Under Soviet dominion lamaism is frowned upon. The Russians have not allowed the appointment of another Hutukhtu to succeed the one who died in 1923. They have curtailed the power of the lamas and are doing their utmost to destroy the hold of the religion over the people. They can make but little progress except by force, I feel sure.

RECENT POLITICAL EVENTS

It is not the purpose of this chapter to discuss the past history of the Mongols or their political condition. Still, the 1922 status of the country and the changes of the last few years are so little known to the western world that a brief sketch of the recent political events may be of interest. Most of them happened while I was in Mongolia.

Until the overthrow of the Manchu régime in China in 1911, and the establishment of the present republic, there were no particularly significant events in recent Mongolian history. At that time the Russians, wishing to create a buffer state between themselves and China, and especially to obtain commercial privileges in Mongolia, aided the Mongols in rebellion, furnishing them arms and ammunition, and officers to train their men.

A somewhat tentative proclamation of independence for Outer Mongolia was issued in December, 1911, by the Hutukhtu and nobles of Urga, and the Chinese were driven out of the country with little difficulty. Beset with internal troubles, the Chinese paid but scant attention to Mongolian affairs until news was received in Peking, in October, 1912, that M. Korostovetz, formerly Russian Minister to China, had arrived secretly in Urga and, on November 3, 1912, had recognized the independence of Mongolia on behalf of his Government.

It then became incumbent upon China to take official note of the situation, especially as foreign complications could not be faced in view of her domestic embarrassments. Consequently, on November 5, 1913, there was concluded a Russo-Chinese agreement wherein Russia recognized that Inner Mongolia was under the suzerainty of China, and China on her part admitted the autonomy of Outer Mongolia. The essential element in the situation was the fact

that Russia stood behind the Mongols with money and arms, and China's hand was forced at a time when she was powerless to resist.

Quite naturally, Mongolia's political status has been a sore point with China and it is hardly surprising that she should have awaited an opportunity to reclaim what she considered to be her own. This opportunity arrived with the collapse of Russia and the spread of Bolshevism, for the Mongols were dependent upon Russia for material assistance in anything resembling military operations, although as early as 1914 they had begun to realize that they were cultivating a dangerous friend. The Mongolian army, at the most, numbered only three or four thousand poorly equipped and undisciplined troops who would require money and organization before they could become an effective fighting force.

The Chinese were not slow to appreciate these conditions, and General Hsu Shu-tseng, popularly known as "Little Hsu," by a clever bit of oriental intrigue sent four thousand soldiers to Urga under the pretext of protecting the Mongols from a so-called threatened invasion of Buriats and brigands. A little later he himself arrived in a motor car and when the stage was set brought such pressure to bear upon the Hutukhtu and his cabinet that they had no recourse except to cancel Outer Mongolia's autonomy and ask to return to their former place under Chinese rule. This they did on November 17, 1919, in a formal Memorial addressed to the President of the Chinese Republic. Naturally the President graciously consented to allow the prodigal to return and "killed the fatted calf" by conferring high honors and titles upon the Hutukhtu. Moreover, he appointed the Living Buddha's good friend (?), Little Hsu, to convey them to him.

Such happy conditions did not last long. The Chinese soldiers in Urga and other parts of Mongolia behaved so outrageously in every way that the Mongols could not endure their tyranny. They entered into communication with Baron Ungern-Sternberg, who agreed to drive the Chinese out of Mongolia if they would give him three million dollars and allow him to use Urga as a base to prepare for his campaign against the Bolsheviks at Kiakhta. He attacked Urga on January 30, 1921, with a force of about five thousand. These included four hundred Russian Cossacks and about a thousand Tartars, the rest of the army being made up of Buriats, Tibetans, Mongols and Japanese. Urga was captured with little difficulty by Ungern, who lost only sixty killed and one hundred and fifty wounded. Then, and subsequently, eight or nine thousand Chinese soldiers were killed. Baron Ungern sent parties to Uliassutai, Kobdo and other points where there were known to be Chinese soldiers, Jews or Bolsheviks. Their massacre was wholesale.

Eventually Ungern left Urga to attack the Bolsheviks at Kiakhta, but was defeated and himself killed. The Reds then came into Urga with the assurance

that they were there to protect the Mongols. By the winter of 1922 they had proclaimed a Mongolian Republic and changed the name of Urga to Ulan Bator, the "Red City." A Mongol Cabinet was appointed in which each Minister was complemented with a Russian adviser. The Mongols were virtually figureheads.

Russian influence has been gradually extended by the introduction of Buriats (Mongols born in Siberia and educated as Russians) into all official positions. At the present time (1930) Outer Mongolia is in all practical ways a Russian province.

The establishment of the Bolshevik régime is, I believe, the last act in the tragedy of Mongolia. The doom of the Mongols, as a race, is sealed.

CHAPTER XIII

DISCOVERY OF THE *BALUCHITHERIUM*

BASE CAMP AT TSAGAN NOR

THE Tsagan Nor region offered a most fruitful field of investigation for every branch of the Expedition. Shackelford and I were busy with zoölogical studies and photography at the lake, while the geologists worked night and day upon their map of the section from Uskuk to Baga Bogdo. Granger reaped a rich and varied harvest of small mammal fossils.

During a single day's prospecting in the Hsanda Gol formation at the "Grand Canyon," Granger picked up one hundred and seventy-five jaws and skulls of carnivores, rodents and insectivores. He maintained his lone camp at Loh and from there made an excursion to Uskuk, where he discovered the fine skeleton of a small dinosaur in the Cretaceous Ondai Sair formation. It was so interesting and complete that I sent Shackelford to Loh to photograph the uncovering and removal of the specimen.

The skeleton proved to represent a new family of iguanodonts to which the name Psittacosauridæ has been applied by Professor Osborn. The Uskuk specimen has been named *Protiguanodon mongoliense* by Professor Osborn. It is a short-skulled, parrot-like beaked, bipedal, cursorial dinosaur, closely allied to another type, *Psittacosaurus mongoliensis*, found a few weeks later in the Oshih basin.

On July 30, Colgate and I went to Loh to visit Granger and Shackelford. We found Shackelford suffering from an attack of hives, and he was very much disgusted when I assured him that he did not have some really interesting disease such as "Gobi fever." This was the only case of illness on the Expedition during the entire summer.

"BONES AS LARGE AS A MAN'S BODY"

Two days earlier Shackelford made a most important find. He was walking down a dry stream-bed near camp and actually stumbled over the distal end of a humerus of a *Baluchitherium*. The huge bone had weathered out of

the perpendicular bank and dropped to the stream-bed. Then we realized that the Mongol reports of "bones as large as a man's body" had some basis in fact. Our first evidence that *Baluchitherium* had inhabited this region during the Oligocene was obtained when Doctor Berkey found a calcaneum and fragments of other tarsal or carpal bones near Iren Dabasu.

I went with Granger to examine the spot and we searched the stream-bed and the surrounding country carefully, but not another trace of the skeleton could be found. Later we went to one of the near-by knolls to prospect for other fossils. The ground was thickly strewn with teeth, jaws, and fragments of skulls, mostly of rodents, but the preservation was bad. Remains of two new genera of Bathyergidæ were prominent because of their size and abundance. Dr. W. D. Matthew described these as *Tsaganomys altaicus* and *Cyclomylus lohensis*. He remarks: "This *Tsaganomys* appears, if properly referable to the family, to be the first fossil record of Bathyergidæ, hitherto known from the recent Ethiopian fauna. It is by no means close to the living genera and should perhaps be distinguished as a separate subfamily, Tsaganomyinæ, on the short massive proportions of skull with heavy forward pitch of occiput, wide differences in otic region and some rather minor differences in teeth. It suggests the Asiatic ancestry of the family, although it cannot be considered as even approximately ancestral to the living genera."[1]

Although many of these skulls were exposed, only a few were worth removing. The bones were so broken and decayed that they could be blown away like dust, and no one less expert than Granger could have taken them out at all.

TAMARISK AND DUNE BERRIES

Colgate and I spent only a day at Granger's camp, and on the way back to Tsagan Nor visited a line of traps which I had set out for a large diurnal sand rat, *Rhombomys*, in a dry river-bed near the "Grand Canyon." At this point the plain was low and thickly covered with a growth of so-called tamarisk, *Salicornia herbacea*. Some of the trees reached a height of fourteen feet but the majority were not more than five or six feet high. The stream-bed led straight down from the range of low lava-capped mountains at the northern margin of the basin and must have been largely responsible for the deeply eroded "Grand Canyon." It indicates, with other evidence, that at some time in the not far distant past there was a period of much greater moisture in this region. The "tamarisk" are most abundant where the waters of the stream debouch upon the plain. Very probably these trees obtained such a firm foothold dur-

[1] Matthew, W. D., and Granger, Walter. 1923. "New Bathyergidæ from the Oligocene of Mongolia," *Amer. Mus. Novitates*, No. 101, Dec. 28, p. 4; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 19, pp. 1–5, 1926.

ing the moist period that they can still send their roots deep enough to find sufficient water to keep them alive. It is significant that no young growth exists.

East and northeast of the lake there is a low area of great playa-tufts, or specifically "sand hillocks." These are formed where shrubs and low bushes net the soil with their roots and form a small hummock at each plant. Drifting sand is entrapped by the growing vegetation and the hillock is, in part, thus built up. Some were six or eight feet high and usually conical in shape. Most of them were covered by a thorny shrub, *Nitraria schoberi*, which we called "dune berry" because of a delicious red fruit which it bears. This was the only edible fruit we found in the Gobi, but it was so abundant in most places that in August, when it ripened, we were usually well supplied. The only disadvantage was the inroads cooking the fruit made upon our sugar.

SAND-DUNES

The geologists in the progress of their map circled Tsagan Nor and crossed the belt of live sand-dunes which lies between the lake and Baga Bogdo. Subsequently we all went over the sand-dunes on camels to investigate a fossil exposure which they discovered. Sand-dunes are an accompanying feature of almost all the lakes which we saw in the Gobi. Professors Berkey and Morris, 1927, write as follows regarding their formation:

"The wind-borne dust and sand forms deposits of several types, depending upon the abundance and quality of the sand, the direction, strength and constancy of the wind, the topography of the region, the rainfall and the vegetation.

"Where the supply of sand is abundant, true dunes arise on the lee-side of the source, and march in the direction of the wind. At the foot of Baga Bogdo, a long scimiter-shaped area of big dunes curves eastward for more than thirty miles from the dissected sediments and dry stream-beds, which furnish the sand. The shape of the dunes varies with the wind. Most of the time, the westerly wind is so strong and constant that the dunes approach the shape of typical barchans. But during violent storms from the east, the shapes become sinuous and irregular, though the crestlines still lie rudely north and south, transverse to the direction of the prevailing winds.

"It was our good fortune to cross the dune belt six times in 1922, twice during high winds which permitted observation of the movement of the sand. A thin sheet of sand-filled air leaped from the crest of the dune, like spray from the crest of a big sea wave. The sand spray dropped upon the leeward side of the dune, down which it ran in long rills that looked like syrup spilling down the face of the dune. New rills started from the crest, or near it, every few seconds. We looked for eddies on the leeward side, and saw some, but

PLATE XXXIV.

RESTORATION OF *Baluchitherium* UNDER THE DIRECTION OF HENRY FAIRFIELD OSBORN.
Painted by Charles R. Knight, 1923.

PLATE XXXV.

A. HALT FOR TIFFIN IN THE SAND-DUNES SOUTH OF TSAGAN NOR, 1922.

B. SKULL OF *Baluchitherium* DISCOVERED IN 1922.

they were small, and were not important factors in shaping the advancing front of the dune. The chief factor was the simple delivery of sand from the back slope to the front.

"With less abundant supply the sand forms thin sheets over the level surfaces, especially on the upland above the valley, or hollow, from which the sand comes. It climbs the windward slopes of hills, blanketing them against effective wind erosion."[1]

When I visited the sand-dunes, I was amazed to find that in the bottoms of the valleys between the dunes there was a considerable quantity of very long, coarse grass, and tall bush sweet-peas bearing beautiful purple flowers. It was evident that water could not be very far below the surface, and in several places Shackelford scooped out a "well" with his hands, finding drinkable water within four or five feet. This is probably due to an accumulation of rain which has drained to these low spots between the dunes. Baga Bogdo is high enough to break up the clouds and precipitate moisture, and very often we watched heavy rain falling on the mountain slope which never reached us ten miles away on the north shore of the lake.

COMPLETION OF THE GEOLOGICAL MAP

Except for a few light showers we had no rain from June 25 until August 3, the night Berkey and Morris returned to camp after completing their map. They arrived just at dark, very tired but satisfied. They had mapped, both topographically and geologically, an area of eight hundred square miles in a strip extending from the northern limit of the basin at Uskuk to the southern margin at Baga Bogdo.

Berkey and Morris were full of interesting details of their experiences on the opposite side of the lake. They had been amazed at the remarkable size of the alluvial fans which debouch from the mouth of every canyon. They ascended one of the fans and found that it was ten miles from base to crest and two thousand feet high. They had encountered sandstorms which almost smothered them and had discovered somber canyons with beautiful cascading streams. It was like listening to a true fairy story, and the camp did not go to rest until the early hours of the morning.

Most interesting was the report of Berkey and Morris of a new fossil-bearing exposure at the foot of Baga Bogdo, and a fragmentary collection of bones. Among the bones I recognized a large cervid and a mastodon; this was sufficient to identify the deposit as Pliocene or Pleistocene and to indicate that we must give it further examination. For the formation Berkey and Morris had suggested the name Hung Kureh.

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, II, pp. v–xxxi, 1–475.

BONES OF A GIANT *BALUCHITHERIUM*

The next evening, while we were silent with awe witnessing the most glorious sunset that I have ever seen, a black car slipped into camp from the north, carrying Granger and Shackelford. Their work at Loh was finished and they came down with all their gear and specimens. Their faces were radiant with suppressed news and when the celestial display was ended and the soft evening light had enshrouded the rugged outlines of Baga Bogdo in a robe of delicate purple, they produced a prize exhibit—newly discovered bones of a giant *Baluchitherium!* These had been found after Granger and Shackelford had broken camp and were on their way to the lake. So it happened all through the summer! We had only to pack and make ready to leave a fossil bed to discover some priceless specimen!

Granger and Shackelford had decided to walk through a still uninspected pocket in the badlands and to have Wang, their Chinese chauffeur, drive the car ahead to a promontory two miles to the south. After a little, Wang decided to do some prospecting on his own account. Almost immediately he discovered a huge bone in the bottom of a gully that emptied into a larger ravine. It was the end of a humerus of a *Baluchitherium*, and other parts were visible, partially embedded in the red earth.

We had impressed upon all our natives the importance of leaving a bone *in situ*, and Wang waited until Granger arrived. Then they found one side of a lower jaw and other fragments of the skeleton. The bones were so hard and free from matrix that they could be easily removed, and Granger brought everything to camp at once.

We talked far into the night, and I awoke next morning filled with a desire to find more of the *Baluchitherium*. Granger could not leave camp, as he was packing fossils to go with the camels which we wished to start eastward as soon as possible. Therefore, Shackelford, Wang and I drove back to Loh to give the gully a more careful inspection. Shackelford and Wang began to dig a trench where the jaw had been found while I prospected the sides of a small dividing ridge. Arriving at the crest of the ridge, I looked down the other side and instantly saw fragments of bone half covered with loose sand in the bottom of the wash. I knew that the bone fragments were portions of a *Baluchitherium* because of the color, and leaped down the slope with a shout. Shackelford and Wang came on the run and in a short time we had unearthed several large fragments; then our fingers struck the end of a huge block in which a loose tooth was embedded. Evidently we had discovered a skull. I knew that it was time to stop, and we returned to camp with our spoils, for I was too excited to do further prospecting that day. We burst in upon camp as the men were having tea. The next day a party returned to Loh to begin the work of removing the huge bones.

The skeleton evidently had been buried at a spot that later became the summit of a ridge between two gullies. As the sediments weathered away, part of the skeleton rolled down one side of the ridge; that was what Wang found the first day. The rest had slipped down the other side into the main wash, where I discovered it. We followed the ravine down to the mouth, rescuing a few fragments that had been carried away by rain action, and Shackelford discovered several important sections of the skull at least three hundred yards out on the plain.

We sifted every square inch of sand, and, at the end of the four days which Granger required to remove the skull, we felt certain that nothing had been overlooked. The huge block was strengthened with burlap and packed in two sections in camel boxes preparatory to its long journey to New York. Professor Osborn has said: "The packing of this skull, its transportation across the desert of Mongolia, its preservation from bandits and from the unpaid soldiery, its journey to Peking, thence to the nearest port and finally its safe carriage to the American Museum, where it arrived absolutely unimpaired on December 19th, 1922—these are among the great events of palæontologic history." The restoration of the skull was begun immediately by Mr. Otto Falkenbach under the direction of Professor Osborn, who made a detailed study of the animal.

First knowledge of *Baluchitherium* was given by C. Forster Cooper, 1911, 1913 and 1923, of Cambridge University, England. In 1911 he discovered, in the Bugti Hills of eastern Baluchistan, two fossil aberrant rhinoceroses—one a small type which he named *Paraceratherium*, and evidences of an animal of gigantic size which he designated *Baluchitherium osborni*. He found only parts of the cervical vertebræ and foot bones and, although from the first he suspected its relationship to the rhinoceroses, he was unable to determine its kinship with certainty. His conjecture was substantiated by the discovery by a Russian palæontologist, A. Borissiak, 1915 and 1916, near Turgai in Russian Turkestan, of remains of a gigantic beast which he named *Indricotherium*. Borissiak found well-preserved grinding teeth and parts of the skeleton which indicated that his specimen and Cooper's *Baluchitherium* were closely related or perhaps identical, but their affinities to other rhinoceroses were uncertain.

Professor Osborn's study, 1923, justified the estimate of its original discoverer, C. Forster Cooper, that it was probably the largest land mammal known. He concluded that the *Baluchitherium* reached a height of seventeen feet at the shoulders and was about twenty-four feet in body length; and that it had a long neck, stilted limbs and shoulders well elevated above the hips as is usually the case in tree-browsers. He is convinced that it had prehensile lips adapted to feeding on the herbage of the higher branches of trees, like a giraffe. With the elevated body-form and massive neck, the head, enormous as

it is, diminishes in relative size, although far exceeding that of any existing mammal in absolute size. The caniniform adaptation of the incisor teeth is remarkable. They are veritable tusks, wielded by a skull of surpassing size and weight and a neck of gigantic proportions, terrible weapons of defense and offense.

The finding of remains of a specialized mammal of such enormous size in regions so widely separated as northern India, Russian Turkestan and central Mongolia is an indication that during the Oligocene period, when it lived, climatic and environmental conditions must have been very similar over all central Asia. That the *Baluchitherium* never reached Europe or America is not surprising. It was too highly specialized to make the long journey to America, and Grabau has shown that it was cut off from Europe by the Turgai Straits, which separated Russo-Scandia from Pal-Asia during Oligocene time.[1]

PLIOCENE FAUNA OF THE HUNG KUREH FORMATION

On August 10 all of us, with three Mongols and a cook, mounted camels for a trip across the sand-dunes to the Pliocene exposures, which had been discovered by the geologists and named the Hung Kureh formation. The formation lies southeast of Tsagan Nor and is exposed in a bold white escarpment, facing west and north. Near the base of the bluff, the lowest beds visible are yellow sands which contain fossils. Above them are fine white sands and light gray clays, forming the face of the bluff, which is about two hundred feet high. The clays and sands are abruptly succeeded by a rubble of coarse pebbles which are only slightly rounded.

Having arrived at the exposures, we spent the afternoon hunting fossils with only indifferent success, and at sundown set off for a spring two miles away where we were to spend the night. We found the cook there and dinner ready. The water was delicious, for it bubbled from a clean gravel basin and spread out in a series of threadlike rivulets bordered by a soft carpet of emerald-green grass.

The next day, until noon, we prospected the beds near camp but failed to find fossils. Apparently they are a somewhat later deposit, and we were anxious to find bones to assist the geologists in dating them. After tiffin we went back to the typical Hung Kureh exposures.

A few hours' work produced a sizable collection of specimens, although most of them were in a fragmentary condition. *Gazella*, *Camelus*, *Hipparion*, *Castor*, *Cervus*, and a mastodont were easily identifiable; most interesting of all were bits of eggshell and toe bones of *Struthiolithus*, a giant ostrich. This

[1] Grabau, A. W. 1927. "A Summary of the Cenozoic and Psychozoic Deposits with Special Reference to Asia," *Bull. Geol. Soc. of China*, VI, No. 2, 3, pp. 183–187.

PLATE XXXVI.

CAMELS IN THE SAND-DUNES NEAR TSAGAN NOR, 1925.

PLATE XXXVII.

A. GRANGER REMOVING A FOSSIL DEER ANTLER.
Foot of Baga Bogdo, 1922.

B. GRANGER INSPECTING A BUSH OF SWEET PEAS.
Sand-dunes near Tsagan Nor.

huge bird was known only from the eggs which had been found in the loess of north China. The eggs are at least a third larger than those of the existing ostriches.

Late in the afternoon I had the good fortune to discover the perfectly preserved antler of a large deer. As I was inspecting a low, rounded ridge of fine yellow sand and clay, I saw some fragments of bone, and following them up found a slight discoloration. From its center the tip of what appeared to be a large tooth was just visible. The matrix was easily worked away and I exposed enough to show that the specimen was a shed antler as large as those of the American wapiti, *Cervus canadensis*. Granger had only two hours in which to remove the specimen, but by skilful work with rice-paper and gum arabic, he took it out in sections and carried it safely back to camp.

Another day's excursion to the "Grand Canyon" produced a hundred jaws and teeth and skulls of small mammals, including rodents, insectivores and carnivores. We found a great quantity of fragmentary *Baluchitherium* bones, but the pieces were so broken that none of them was of value. They must have come from several skeletons which had been exposed and entirely disintegrated by weathering. Doubtless this locality will produce a more or less complete *Baluchitherium* skeleton sooner or later.

HOMEWARD FROM TSAGAN NOR

Sunday, August 13, was the day appointed for leaving our beautiful camp at Tsagan Nor. We could already feel an autumn sharpness in the morning air, and water-fowl were dropping into the lake only to leave for the south in a day or two. The sand-grouse had gathered into enormous flocks which swept in a gale of brown wings above our tents, flying usually from west to east parallel with the mountains. We must travel a thousand miles through virtually unknown country about which little information could be gleaned from the few Mongols we had seen. We expected to move independently of the main caravan trails; if the terrain were fairly good we would have time for further investigation, but if the region proved to be impassable we might be compelled to turn back and seek a different way out. I felt some concern, for we had only enough gasoline to take us comfortably to Kalgan.

We planned to travel along the Kweihwating-Kobdo trail, which passes just north of Tsagan Nor, skirts the eastern end of Baga Bogdo and continues past Artsa Bogdo fifty miles farther to the east. The caravan left on the day of our departure, with instructions to meet us at Artsa Bogdo. The Mongols reported Artsa Bogdo to be a particularly good district for ibex and bighorn sheep, and it was probable that we would also find sedimentary basins worthy of palæontological investigation.

SURFACE WATER AND WATERFOWL

Twenty miles from Tsagan Nor we halted near two small ponds bordered by marshland. They were alive with ducks and geese and we saw an opportunity to relieve the monotony of our antelope-meat diet. In an hour we got twelve graylag geese, eight mallard ducks, one whooper swan, three jack-snipe and two beautiful painted snipe, *Rostratula benghalensis benghalensis*. The swan was winged-tipped by a single shot and we caught it only after a lively chase. I grasped it by the neck but relinquished it just as quickly, for the bird was able to strike such a powerful blow with its wings that it was really dangerous to one's legs and arms. After photographing the swan we released it upon the largest pond; doubtless it would soon be able to fly again. Having tried to eat adult swans and found them as tough as rubber, I had no desire to risk any of the Expedition's teeth.

A short distance east of the ponds we reached a series of small streams which drain from the northern slopes of Baga Bogdo. They were only two or three feet wide, but their steep banks gave us much trouble. We had to bridge them with turf-sods, and all the men were exhausted by the time the last stream had been crossed. The water-table lies so close to the surface that the cars were in almost constant danger of miring.

We saw more surface water in this region than elsewhere in the Gobi. Some of the streams actually flow for miles across the plain. About thirty miles east of Tsagan Nor there was a large valley leading toward the northeast away from the mountains. Regarding the valley, Professors Berkey and Morris, 1927, remark: "It must have been made by stream erosion where now no competent stream exists. This is another of the numerous evidences of changed climatic conditions. With the present rainfall it would be impossible to carve a valley of such magnitude. Therefore, the presence of these forms, demanding different conditions for their sculpturing, lends strong argument for a different climate in former times. There must have been more water, and there must have been greater streams—for valleys were carved out which are now slowly filling or are kept cleaned out by the work of the wind, which helps to remove the new deposits."[1]

A DESERT OASIS

The basin, watered so abundantly from the Baga Bogdo streamlets, was a veritable oasis in the desert. There were no trees, of course, but a carpet of emerald-green grass which contrasted strongly with the brown gravel hills on either side. Hundreds of sheep, goats and ponies drifted along the valley bottom and a score of yurts dotted the slopes. When I turned my back to the

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, pp. v–xxxi, 1–475.

desert and looked over the green meadow to the rugged slopes of Baga Bogdo, it was difficult to realize that we had not suddenly been transplanted to a valley of the American Rocky Mountains.

The Mongols were most friendly, and we recognized several who had competed in the field meet at Tsagan Nor. They greeted us like old friends and gained much "face" with their less sophisticated neighbors by "explaining" the workings of our motor cars.

We were all tired by the time the bad going of the valley had been crossed, but our reward awaited us in the form of a slightly rolling gravel plain as hard and smooth as a tennis court. The centuries old trail showed as a faint line for miles ahead. The short, stiff bunch grass was greener than that of the desert to the west, and isolated volcanic outcrops showed black against the sky.

CAMP VOLCANIC CLIFFS

At about eight o'clock we camped in the picturesque canyon of a tiny stream which had cut its way through a low ridge of volcanic hills. The water was charged with mineral matter, but the indefatigable Shackelford dug a well in the loose sand and gave us drinkable water in an hour. Our day's run had been only forty-five miles, due to the bad going and a late start from Tsagan Nor.

The next morning dawned clear and sunlit with a stimulating sharpness in the air. We drove across an oldrock floor of pre-Cambrian conglomerates, limestones and other rocks on a beautiful hard trail. At either side craggy remnants of the ancient rock stood up two or three hundred feet in height, and the trail passed through gaps and saddles between them. We had a fruitless chase after two wolves, but they outwitted us among the rocks. We drove merrily on to sweep around a great promontory and view the rounded mass of Artsa Bogdo rising from a gently lifted, green-clothed plain. As we waited for the other motor cars to arrive, five wild asses accompanied by a small herd of gazelle trotted into view. This was our "farthest east" record for wild ass at the time, but subsequently we found that the limit of their range was the Gurbun Saikhan.

MONGOLS AT ARTSA BOGDO

At a long yurt beside the trail, an old hunchback Mongol told us that there were several native encampments at the base of Artsa Bogdo. With the field-glasses we could see yurts and started across country toward the largest village. Two Mongols herding camels near the trail saw us coming, deserted their charges and dashed for the mountain. They reminded us of wild asses for they would ride some distance at full speed, and then stop to gaze back at us. They never had seen or heard of a motor car and curiosity almost overcame their fear.

Although the mountain appeared to be not more than three miles away, we discovered that it was ten miles and the rise from the trail was one thousand feet. Our motors were boiling under the heavy loads on the long grade before we reached the nearest village. Panic was the order of the day. Men and boys threw themselves on ponies and dashed for the mountain. Women and girls, of less account, perforce took refuge in the yurts, for we came too rapidly to make escape on foot practicable.

When the cars reached the village, our Mongols entered a few of the yurts to assure the inhabitants of our friendly intentions. Soon one or two ventured reluctantly outside, and in half an hour most of the women and old men were assembled about the cars. The able-bodied men who had been watching from the shelter of the hills began to straggle back when they saw that the expected slaughter had not materialized. It was an illuminating commentary on the deathly fear which the bloody events of the last two years had inspired in these peaceful desert dwellers.

The tents were pitched on a grassy slope half a mile above the village and right at the base of the mountain. Before us unfolded a magnificent panorama of desert and "badlands" and about the camp there was a delightful atmosphere of cleanliness, height and freedom. We looked forward to an interesting fortnight, for the Mongols assured us that the mountains swarmed with sheep and ibex, and the badlands looked decidedly possible for fossils.

CHAPTER XIV

ARTSA BOGDO

THE ARTSA BOGDO RANGE

The Baga Bogdo range of the Altai Mountains is separated from the Artsa Bogdo unit by lower ground, and is slightly offset to the south from the direct east and west line, but in general view the two appear to be a single continuous chain. The western mass of Artsa Bogdo is high and rugged and separated by a "saddle" of lower hills from the eastern end, where the mountains are high but consist of rounded grass-covered summits with comparatively little rock exposed.

We were camped at the base of the saddle on the edge of a deep gorge, cut by a stream straight through the mountain. Two wells in the bottom of the river-bed gave us delicious water, and in a day we were on friendly terms with our new neighbors. There were three groups of fifteen yurts each, separated by perhaps half a mile. Sheep, goats, cattle and ponies enjoyed the abundant grass, and ten miles away we could see the brown patches of camel herds feeding on the dry thorny vegetation of the desert. We soon learned the reason for the sharp demarcation of grassland and desert, for often we were drenched with rain which fell on the mountain slopes but seldom reached the desert plain a few miles away.

A HUNTING TRIP FOR SHEEP AND IBEX

The Mongols of the villages soon realized that not only had we brought much of interest into their dull lives but that we were ready to pay well for the assistance which they could give. On the first afternoon I engaged a lama guide to take me shooting the following morning. I rose before the first gray light of dawn and, mounted on a tiny twelve-hands-two pony, rode up the dry streambed in the bottom of the canyon for about three miles. The air was clear and cold; quail, *Coturnix*, buzzed continually out of the long grass at our feet; the familiar call of red-legged partridges, or chukars, *Alectoris*, sounded on every side; conies whistled constantly and a fox barked at me from the shelter of a rock. After our long weeks in the desert it was delightful to have my leg across a pony and to breathe the mountain air again.

We came upon a herd of thirty female and young ibex shortly after we had climbed out of the canyon to the upper slopes of the hills. I was surprised at the color of the animals—a rich nut-brown, like roe-deer in the winter pelage. I did not have a shot, but a few hours later knocked over an old female as she dodged among the rocks on the rim of the gorge. Her long beard, short horns and yellow eyes made her appear very goat-like; her dark brown coat so perfectly matched the color of the rocks upon which she lay that she was well-nigh invisible.

I saw fifty-seven ibex that day and two bighorn sheep, but all were females or young. Subsequently we learned that during the summer and until the rutting season the male ibex live among the high, rough peaks of western Artsa Bogdo, and only an occasional straggler wanders into the lower hills where we were hunting.

PREHISTORIC PICTURES

When I returned to camp just before sunset I found that the geologists, with Granger and Colgate, had prospected some extensive exposures of red beds between the mountain and the trail, without discovering fossils; also, that they had investigated an interesting mesa south of the trail. It is capped with black basalt, and the white and red sediments showing on its scarred flanks make a spectacular color combination. The absence of fossils was very surprising, for although the age of the sediments is unknown, the aspect is like that of some of the Tertiary beds near Tsagan Nor.

I did not visit the mesa, but Doctors Berkey and Morris, 1927, remark concerning it.

"On some of the basalt blocks on the white-cliffed mesa, we noted a striking display of prehistoric pictures. One group of these, found on a large, flat fragment, carries the following: two men, one with bow and arrow, several animals, one of which was probably intended to represent a horse, another a reindeer, another possibly a moose, while still another is perhaps a fox. None of these animals, except the fox and the horse, is to be seen within several hundred miles of this region at the present time, yet it must be that the artist was familiar with them. Either he belonged to a tribe which came from a region where these animals were native, or else the region itself was occupied in his time by such animals. It is entirely reasonable to believe that the latter is the explanation, and that the artist pictured animals living in his vicinity. This interpretation would mean that the people who made these drawings were not of the Mongol race, and that the climate was other than it is now."[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, pp. v–xxxi, 1–475.

PLATE XXXVIII.

A. IBEX COUNTRY ON ARTSA BOGDO, 1923.

B. MONGOLIAN IBEX, *Capra siberica*, 1923.

PLATE XXXIX.

A. A VALLEY ON THE SLOPES OF ARTSA BOGDO, 1923.

B. THE "SHIRTO HOUSE," A CAVE ON A SUMMIT OF ONE OF THE PEAKS OF ARTSA BOGDO, 1923.

Future study of petroglyphs of this type by our archæologist, Mr. Nelson, confirmed the geologists' opinion that they were made by a pre-Mongol people.

CARAVAN AFFAIRS

The next day a heavy rainstorm kept us all in camp. Just at sunset we saw a dark blotch on the plain. Our Mongols, with their wonderful eyes, assured us that it was our caravan, and before long, with glasses, we could

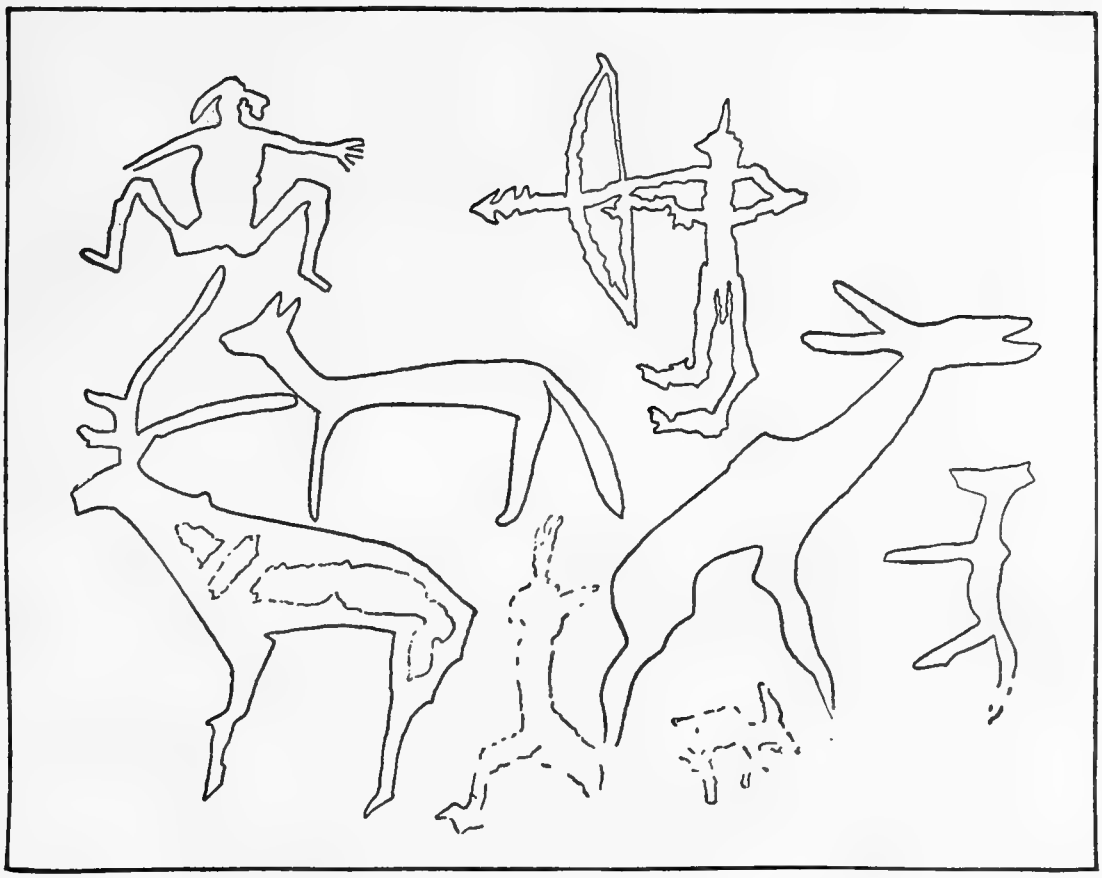


FIGURE 9.—Drawings cut upon a basalt block at Artsa Bogdo. From "Geology of Mongolia."

distinguish the American flag; an hour later we saw a single rider loping up the slope and Merin came into camp. When I complimented him upon his prompt arrival he remarked: "You said to come in three days and so we did." But the distance was twenty miles greater than we had estimated when I told him that!

The baby wild ass which had been with us since we captured it on July 6 at Tsagan Nor, died August 18. We had not been able to wean it and were

never able to get a sufficient quantity of goat's milk; at Artsa Bogdo there was cow's milk in abundance and the little animal developed severe diarrhœa, resulting in death. "Buckshot," the Chinese boy who tended it, was the only member of the Expedition whom it would tolerate.

It was important to start the caravan immediately toward Sair Usu, a well on the old Chinese official road which we hoped to reach on our return journey to Kalgan. The camels could travel overland regardless of the terrain but just how we were to reach Sair Usu was uncertain. We took food and gasoline enough for three weeks, and the caravan left August 20.

IBEX AND BIGHORN SHEEP

Granger decided that he could prospect the Artsa Bogdo basin more successfully from a base down on the plain, so he left us to camp at a spring fifteen miles to the north. Berkey and Morris wished to study the Artsa Bogdo uplift and the region directly to the south. They could best do this by riding through the mountain itself on camels and ponies. With a guide and animals hired from the natives, they left on the nineteenth; thus the Expedition was again divided into four units. My own task was to collect a group of ibex and sheep for the Hall of Asiatic Life, and see that the taxidermists obtained a representative collection of the small mammalian fauna.

I hunted the mountains behind camp for several days and discovered that none but females and young of either sheep or ibex were to be found there. My native guide assured me that big rams of both species were abundant in the high peaks of the western part of the range. Consequently, I engaged a Mongol lama as guide and rode away for a four-day shoot. Our method was to fill two canvas water-bags and our canteens, ride to the highest peaks, and sleep wherever we found game. As there was no water on the mountain summits, we rode down to some stream in a valley bottom, after the early morning shoot, to water the horses and ourselves.

I had ridden the Mongol ponies for months over the desert and grasslands, but this was my first experience with the animals in mountain climbing. They amazed me by their strength, endurance and sure-footedness on slopes so steep as to be seemingly impassable for any animal as large as a pony. The western end of Artsa Bogdo is cut by two or three deep gorges with partly dry streambeds in the bottoms. The tremendous erosion which has taken place indicates that at some time in the past there was a period of moisture, when heavy rainfalls enabled the rivers to do their work. One of the gorges is at least seven hundred feet deep for most of its way.

My Mongol guide proved to be one the best hunters whom I have ever had. He had hunted all his life, until three years before, when he had become very ill. Believing that he was about to die, he made a vow to Buddha that if

he recovered he would become a lama. As a result he was supposed not to take life, but his natural passion for hunting was too much for him, and frequently he stole off to use the old flintlock gun which he kept concealed in a small rock-cave. He had an almost uncanny knowledge of what the game would do, and just as great skill in stalking. He never had seen a high-powered rifle operate, and it so happened that, the first time he was with me, I killed two sheep across a ravine at a range of four hundred yards. He was literally speechless with astonishment, and more amazed, if possible, when he saw the tiny 6 mm. bullet and then examined the hole it had torn in the sheep's side. As a result he believed that I could kill an animal as far as I could see, and it took some time to convince him that there was a limit to the range of my rifle.

I found that the Mongols were quite right in saying that the big rams of both ibex and sheep were among the western peaks. In the four days that I hunted there I saw about one hundred and fifty ibex and half as many sheep. As far as I know we were the first white men to hunt the mountain, but the animals were by no means unwary, for the Mongols continually pursue them during the winter. The following year McKenzie Young and I spent three weeks shooting on this same mountain, and visited it again in 1925 with six of the Expedition members.

Neither the male nor female ibex is ever very far away from rocks. We often found bighorn sheep in ibex country, but never saw ibex out on the rolling grassy hills which sheep love. During the summer the ibex and sheep both feed from the first gray light of dawn until the sun is high; then they sleep in the shade until about two hours before dark, when they begin to move about again, keeping well in the shadows. A saddle or a depression on a ridge is a favorite sleeping place because there the wind reaches them from every side. They depend much less upon their sight or hearing than upon smell to protect them from enemies. They seem to know by instinct those spots "where the baffling mountain eddies chop and change."

The dark brown of the summer coat of the ibex is a marvelous protective coloring. Often I have surveyed the side of a rock-cliff with my field-glasses, scrutinizing every inch, yet nothing would be visible until a movement would show that what I thought was a rock was in reality an ibex. The females are much more difficult to see than the males, because the long curved horns of the latter often will show in silhouette when the body is concealed.

Sheep and ibex are seldom off guard. When a herd is feeding or asleep two or three sentinels are posted. One morning, Young and I watched forty ibex graze up an almost perpendicular mountain side until the last foot of shade had disappeared, and then dispose themselves comfortably among the rocks. They were plainly visible while they were standing, but one by one they faded

from sight and seemed literally to sink into the ground. Only two bucks were left. They climbed lazily to the highest peak and took stations side by side facing in opposite directions. One surveyed the vast complex of mountains to the south; the other gazed over the plain, which stretched away like a calm sea. For two hours they stood motionless, living statues silhouetted against the sky. Then, at the same moment, they left the sentinel post and lay down. We watched a similar performance with a herd of sheep. In that instance one ram remained on guard. He climbed to the topmost pinnacle of rock on the highest hill nearby and stood as if carved in stone. Eventually he left and lay down himself, leaving the herd unguarded.

One hears a great deal about the enormous sheep and ibex heads of the Altai and Tien Shan. There seems to be no question that the Tien Shan ibex do produce larger horns than those of the Altai. Also, larger bighorn sheep live in the western Altai than in the eastern part of the same range where we hunted. We always found the largest ibex and sheep in the highest and most rugged mountains, and, of course, the eastern Altai do not compare in height with the western part of the range.

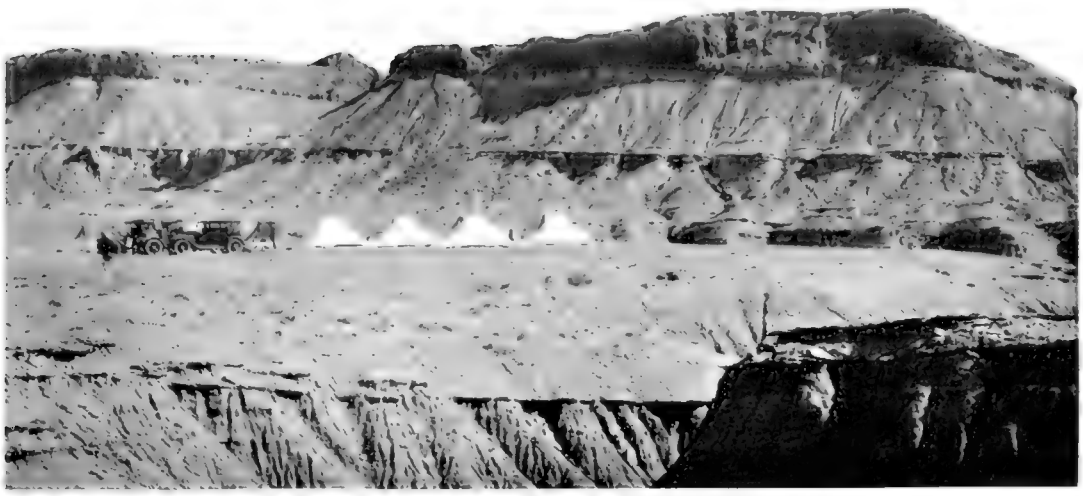
We shot twenty-five specimens on the Artsa Bogdo in 1922, 1923, and during that time I counted several hundred ibex and half as many sheep, yet I did not see more than ten sheep with strikingly large horns. I saw only three ibex with horns that would have measured fifty inches or more. One day I killed two ibex from a herd of nineteen bucks; the horns of one measured thirty-seven inches and of the other forty-one inches. I inspected the herd carefully before shooting and am sure that none of the animals carried horns larger than those of the ones killed. Lieutenants Butler and Robinson shot an ibex with forty-one-inch horns, as did Doctor Loucks in 1925. I should say that the usual horn length for the Artsa Bogdo ibex is about thirty-six inches. The horn average for the sheep on this mountain is about forty-five inches in length with a basal circumference of eighteen inches. As I have remarked, I did see about ten sheep with horns which must have been close to sixty inches in length and twenty inches in circumference at the base. Unfortunately, none of us got a sheep with horns longer than fifty inches; neither did we see any large horns lying on the mountain slopes. The Gurbun Saikhan, the next eastern mountain unit, is still lower than Artsa Bogdo and consists of grassy hills and plateaus. It is ideal sheep ground and there are many argali there, but we saw no really large ones, and the natives told me that big rams were rare. Farther east the Altai Mountains dwindle into isolated and still lower units, almost all of which are inhabited by sheep. I am convinced that the big heads are to be found in abundance only in the western Altai among the higher mountains.

J. H. Miller remarks:

PLATE XL.

TSERIN POINTS OUT APPROACHING CARAVAN TO ANDREWS, CHIMNEY BUTTE, 1928.

A. ANCIENT WALL AT THE BASE OF THE RED MESA, OSHIH BASIN, 1923.



B. EXPEDITION CAMP IN THE OSHIH BASIN, 1923.

"Though more than one Russian explorer mentions having met sheep in the eastern Altai, it is to Sir Francis Younghusband that we are indebted for by far the most interesting information on this subject. In his remarkable journey of 1887 across the Gobi, from Peking to Hami, he struck the great Altai at its most easterly extremity in longitude 100° East. He estimated the height of the range, even at its terminal portion, as 9,000 feet above sea-level, and the natives reported grassy plateaux in the centre. These two combinations sound suitable for *ammon*. Though Sir Francis did not visit these high plateaux, where the sheep would have been at that season (July), yet on the outlying southern foothills horns were found lying on the ground which, from their great girth of 19 inches and general shape, undoubtedly belonged to *Ovis ammon typica*."[1]

The most eastern point at which we hunted sheep was Jichi Ola, a low isolated mountain at Longitude E. 106°, Latitude N. 43°31′. This is nearly five hundred miles east of Younghusband's records. From the motor cars we saw sheep at several other isolated mountains which were at the very extremity of the main Altai chain.

We saw demonstrated beyond a doubt the fact that sheep will cross considerable stretches of open plain to reach a distant mountain. About four miles north of Jichi Ola there was a small, low mountain standing alone in the desert. One day Granger discovered a herd of ewes led by a young ram far out on the plain proceeding leisurely toward the isolated mountain. He followed them in his car and found that the highest speed which they could reach was twenty-five miles an hour. They quickly became exhausted and gathered into a compact group. He stopped a hundred yards from them and while he was trying to get his camera the sheep suddenly separated and dashed away. They were doubtless making this pilgrimage to escape from the higher mountain where we had been shooting for two days.

McKenzie Young and I were hunting at the extreme eastern end of Artsa Bogdo in 1923. We had been following a large herd of sheep and were surprised to see them leave the mountains and dash across the desert to the southeast. Another herd abandoned the plateau to go out upon the plain, but we met them again returning to the foothills several hours later. The Mongols at Artsa Bogdo told us that they often saw sheep crossing ten or fifteen miles of desert from one mountain to another. Typical *Ovis ammon* ranges as far east as Longitude E. 110°, for I discovered a skull with good horns lying in the grass near Gatun Bologai, a well-known spring on the Kobdo-Kweihwating trail. This was half a mile from a low, ragged granite outcrop about five hundred feet high. Between it and Jichi Ola there are isolated mountains, not more than five or ten

[1] Carruthers, Douglas. 1914. "Unknown Mongolia." With three chapters on sport, by J. H. Miller. Hutchinson & Co., London, p. 346.

miles apart, which probably act as "stepping stones" for the sheep. According to the Mongols these lowland crossings take place during the winter months. I believe that Longitude E. 110° is the utmost eastern range of true *Ovis ammon*. Several hundred miles of arid flat desert separate this point from the mountains of the Sino-Mongolian frontier, where another related species, *Ovis comosa*, is found. Dr. Glover Allen, after studying specimens of *Ovis comosa*, concludes that it does not differ specifically from the true *Ovis ammon*.

Miller speaks of frequently seeing wolves in the western Altai where he hunted *ammon*, but we did not see a single wolf or any traces of them at Artsa Bogdo. I have already remarked how scarce they are upon the desert, but we had expected to find them in the mountains. Except for man, the sheep and ibex have no important enemies in this region, unless the lammergeyer may be counted as one. Probably this great vulture does get a good number of lambs but I doubt whether it attacks adult sheep or ibex.

ARTSA BOGDO FAUNA

Both the avian and the mammalian faunas have followed this far eastern extension of the Altai from the high mountains of the west. It is also inhabited by several species of birds and mammals common to the mountains of north China and Mongolia, both north and south of the desert. We never saw the lammergeyer except in the Altai; also, the snow-cock, *Tetraogallus*, was an Altai bird not observed elsewhere. The chukars, quail, bearded partridges and red-billed chough, all birds of the north China and Mongolian border mountains, were abundant at Artsa Bogdo. The mole-rat, *Ellobius larvatus*, of the Altai we caught at Sain Noin as well as at Artsa Bogdo. The cony, *Ochotona pallasi*, was not peculiar to Artsa Bogdo, as the same species was collected at Uskuk, Gun Burte and Tsetsenwang. The spermophile, *Citellus obscurus*, the marmot, *Marmota bobak siberica*, and other small mammals were also found at other localities in the Gobi.

Marmots were fairly abundant on the high plateau of the mountains, although there was no sign of them on the lower slopes. This was unlike any other spot where I have encountered marmots; usually they prefer the foothills to the high mountains. I cannot believe that it was because they had been driven away by Mongols, for in that case we would have seen abandoned burrows. Conies were very numerous, and in the meadow-like plateau between the peaks their little haycocks dotted the slopes; some of them were as much as two feet in height.

The quail and chukar partridges were extraordinarily abundant, and as the young were just able to fly well they gave us good sport and delicious food. When we returned the next year (1923) there was hardly a bird to be found; in three weeks' shooting I saw only two quail and one chukar on the mountain.

What happened to almost exterminate them I cannot imagine. The natives said that the winter had not been unusually severe. Both in 1922 and 1923 there were many *Ovis ammon* on Artsa Bogdo, but in 1925 our shooting parties saw only two or three sheep, although the ibex were as numerous as in previous years.

The snow-cock was a new bird to me, for it is an inhabitant of the Himalayas and the western Altai. We found the birds only among the rocks on the highest peaks. They utter a weird, rapid-fire call when sailing across a ravine from peak to peak, a call which seems to fit the wild mountains among which they live. I saw them only when I was hunting ibex and could not shoot for fear of disturbing larger game, but my Mongol, Tserin, was very anxious to have me kill one or two for him. He said that the Chinese esteem the meat for medicine, as well as the dried blood. I said, "Tserin, do you really think the meat would cure you if you were ill?"

"Probably not," said he, "but the Chinese will pay ten dollars for it and that is good enough for me!"

Artsa Bogdo takes its name from the low juniper, *Juniperus sabina*, which the Mongols call artsa. This plant spreads over the rocks and grows in masses in the bottoms of the depressions and ravines among the mountain heights. The bighorn sheep often sleep in the artsa and we followed their example with great comfort. The artsa is confined to the western end of the mountain. I saw none of it on the grassy hills of the central and eastern parts, where there are few rock outcrops.

GEOLOGICAL RECONNAISSANCE SOUTH OF ARTSA BOGDO

On August 28, Berkey and Morris returned from their trip across the mountains. They had traversed the desert to the south of Artsa Bogdo, reached the western end of the Gurbun Saikhan, and returned by a different route. It had been a trying expedition, for both men were pretty well exhausted from their strenuous work at Baga Bogdo, and the weather was hotter than any we had experienced earlier in the season. Nevertheless it had been profitable, and after a few days' rest they were fit again.

Beside making geological observations they discovered some palæolithic artifacts of chalcedony near a spring on the south side of Artsa Bogdo. These were the first indications that we had had of any very ancient human occupation of the region. They also found a few fossil bones which Granger decided were dinosaurian, thus identifying Cretaceous strata south of the Altai Mountains.

THE FIRST PALÆOZOIC FOSSILS

Perhaps most important of all the finds by Berkey and Morris was a single piece of red limestone containing invertebrate fossils. Dr. A. W. Grabau, who

examined it, said that the fossil fragments, which include crinoids and corals, suggest either late Devonian or Dinantian age. It was particularly interesting as being the first evidence of Palæozoic strata found in Mongolia (see Vol. IV, this series, p. 22).

GEOLOGIC STRUCTURE OF ARTSA BOGDO

Regarding the general structure of Artsa Bogdo, Professors Berkey and Morris, 1927, have said:

"The representatives of the Altai system in the mid-Gobi owe their uplift and relief to block faulting. A row of narrow blocks, whose longer axes lie east and west, has been elevated and tilted. The whole system dies out toward the east, each block being lower than its western neighbor. It is an incidental matter that the rocks involved have exceedingly complicated structural features and exhibit close folding nearly parallel to the elongation of the block.

"The Artsa Bogdo differs from the Baga Bogdo unit in that the dominant rock formations are crystalline metamorphic representatives of the ancient series, whereas Baga Bogdo exposes an immense area of granite, flanked by metamorphic series. This difference, we judge, is in large part the result of a different amount of elevation and erosion. Most of the stratified and metamorphic cover of Baga Bogdo has been stripped from the underlying bathylithic granite, whereas from Artsa Bogdo the stripping is not so complete and the usual cover of ancient metamorphosed strata is preserved throughout most of the range."[1]

OSHIH BASIN

We were entranced with the open park-like tracts in the central and eastern part of the Artsa Bogdo unit. Long meadows, as smooth as a putting-green, swept down from rounded grassy summits into gently undulating valleys like the billows of a great ocean swell. From them we could look across the blue haze of desert far below us to the dim outlines of a blood-red mesa forty miles to the north. We did not know until after we had left the mountain that this superb mesa stood in the center of a basin, or desert-hollow, which Granger had discovered and where he was then at work. We named it the Oshih Basin. The fossiliferous exposures were of Lower Cretaceous age.

On August 30, we left Artsa Bogdo and moved to a spring a few hundred yards from the trail. Granger had camped there for several days and had sent word that he would despatch a man to guide the geologists to his new fossil-

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, pp. v–xxxi, 1–475.

bearing basin which he described as well worth investigation. Since I had much to do in preparation for the start of our homeward journey on September 1, I remained in camp with Shackelford.

The geologists and Granger returned the next day. They were in the highest spirits and had several boxes of fossils. Granger reported the basin to be a wonderful spectacle of erosion; an amazing chaos of canyons, ravines and gullies, in the midst of which stands the red mesa capped with jet-black lava. There were remains of an interesting ancient wall made from lava blocks, probably pre-Mongol, and an abundance of fossils.

Granger brought in two skeletons of small dinosaurs, one of which was beautifully preserved, including an almost perfect skull and jaws. The specimen was discovered by Wang, the Chinese chauffeur who had found the first bones of the *Baluchitherium* at Loh. Professor Osborn named this dinosaur *Psittacosaurus mongoliensis*. It is allied to, or possibly identical with, *Protiguanodon* from the Ondai Sair formation of Uskuk. Professor Osborn remarks:

"These two types resemble each other in so many characters that they obviously belong to a distinct family of iguanodonts to which the name Psittacosauridæ has been applied. These short-skulled iguanodonts derive their family name Psittacosauridæ from the very deep parrot-like beak, with small nostrils located at the top of the very deep maxilla."[1]

Granger made another important discovery, consisting of two characteristic teeth of a large sauropod dinosaur. Professor Osborn, 1924, names the sauropod *Asiatosaurus mongoliensis* and concluded that the teeth resemble *Camarasaurus*. Also, two other teeth, of a carnivorous dinosaur designated *Prodeinodon mongoliense*, were found in the same formation. The discovery of both Sauropoda and Theropoda added two more great groups to the list of Mongolian prehistoric fauna which our single season's work was bringing to formidable proportions. The formation was named Oshih (Ashile), and it includes the oldest of the later sediments lying upon the complex oldrock floor of Mongolia. Since the dinosaurs *Psittacosaurus* and *Protiguanodon* found in the Oshih and Ondai Sair formations are possibly identical or at least very closely related, they indicate that the two formations are of approximately the same age. This may be said to be near the beginning of the Lower Cretaceous.

Granger had been away for ten days and had been so busy removing specimens that he had had little time to prospect the great depression. The basin gave promise of being a most important fossil locality, but, strangely enough,

[1] Osborn, Henry Fairfield. 1924. "*Psittacosaurus* and *Protiguanodon:* Two Lower Cretaceous Iguanodonts from Mongolia," *Amer. Mus. Novitates*, No. 127, p. 1; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 25, pp. 1–16, 1926.

subsequent work showed that it was the only one of our 1922 localities which did not fulfil expectations.

I had set September 1 as the date of our departure, for we had many hundreds of miles of unknown country to traverse and there were abundant signs of approaching winter. Baga Bogdo had already assumed a new crown of snow and we might expect a blizzard at any time. A heavy fall of snow would be disastrous, for, even if it did not remain long, it would make traveling difficult for our motors wherever there was soft ground. Therefore, we marked the Oshih Basin as a field for further investigation and prepared for the homeward trip with light hearts.

CHAPTER XV

DISCOVERY OF THE FLAMING CLIFFS AND ARDYN OBO

EASTWARD FROM ARTSA BOGDO

Our last camp opposite Artsa Bogdo mountain was on the ancient Kobdo-Kweihwating trail, ten miles north of the mountain. We decided to follow the trail eastward to the vicinity of Ulan Nor and then try to strike northward to the Uliassutai-Sair Usu road, which we believed could be traveled safely into Kalgan. If this route proved impracticable we should have to find some other way to Kalgan.

The crisp cold air, the uncertainty of travel and the prospect of new and interesting country put everyone in high spirits. Nowhere in the world have I known air so invigorating as that of Mongolia in the autumn. The altitude, nearly five thousand feet, and the desert dryness make even the warmest days of summer bearable, and the really hot weather lasts only about a month. The final two weeks of August and the first part of September bring an autumn sharpness which is as delightful as it is stimulating. Our bodies surged with vigor and the most strenuous work seemed not to tire us. It is easy to believe that the proper theater of evolution for the human race must have been on uplands with a summer climate similar to that of the present-day Mongolia, rather than in the tropics with their debilitating heat.

We left on Friday, September first. Driving eastward with the dark mass of Artsa Bogdo still in sight, we made excellent progress over a hard trail. The cars were heavily loaded, for we had filled all available space with gasoline and Granger's collecting in the Oshih Basin had added several heavy boxes of fossils. Thirty miles down the trail an accident to the clutch of one car delayed us nearly a day, but the geologists utilized the time to make closer investigations of the geological features of the region. Continuing southeastward we found the trail for the most part good, except in three or four places where it was amazingly bad. Fifty-three miles from Artsa Bogdo we found a shallow basin filled with "nigger-heads," where the water-table was close to the surface and the red soil soft and wet. It was difficult terrain, and the heavier cars were often mired so badly that we had to unload and dig them out. For many miles

we had seen no Mongols. We hoped to find natives who could give us information of any caravan trails leading northward, but it was not until we were sixty-five miles east, opposite the low-lying mass of the Gurbun Saikhan, that we saw a group of yurts some distance off the trail.

FOSSILS AT SHABARAKH USU

My car was far in advance of the others and I asked Shackelford to stop the fleet while I ran over to the yurts for a conference with the inmates. During the time that I was gone he wandered off a few hundred yards to inspect some peculiar blocks of earth which had attracted his attention north of the trail. From them he walked a little farther and soon found that he was standing on the edge of a vast basin, looking down upon a chaos of ravines and gullies cut deep into red sandstone. He made his way down the steep slope with the thought that he would spend ten minutes searching for fossils and, if none were found, return to the trail. Almost as though led by an invisible hand he walked straight to a small pinnacle of rock on the top of which rested a white fossil bone. Below it the soft sandstone had weathered away, leaving it balanced ready to be plucked off.

Shackelford picked the "fruit" and returned to the cars, just as I arrived. Granger examined the specimen with keen interest. It was a skull, obviously reptilian, but unlike any with which he was familiar. All of us were puzzled. Granger and Gregory named it *Protoceratops andrewsi* in 1923. Shackelford reported that he had seen other bones, and it was evident that we must investigate the deposit.

We could see a small pond on the bottom of the basin, and two Mongol soldiers whom I had brought with me from the yurts said that there was a well near-by. We decided to camp where we were and utilize the three or four remaining hours of daylight to prospect the exposure. The tents were pitched on the very edge of the escarpment, and every available man of the expedition, native and foreign, went down into the badlands. Quantities of white bones were exposed in the red sandstone, and at dark we had a sizable collection. However, Shackelford's skull still remained the best specimen, with the possible exception of the skull and jaws of a small reptile, found by Berkey.

Granger brought in, among the other things, a part of an eggshell which we supposed was that of a fossil bird, but which subsequently was recognized as dinosaurian. It was evident that the formation was Cretaceous and very rich in fossils, but at that time we could do no more than mark it as one of the localities for future work. We could hardly suspect that we should later consider it the most important deposit in Asia, if not in the entire world. Subsequently it was formally designated as the Djadochta formation of Shabarakh Usu.

PLATE XLII.

A DETAIL OF THE FLAMING CLIFFS, SHOWING WIND EROSION.

PLATE XLIII.

A. "THE DINOSAUR," A NATURAL WIND-CARVED RED SANDSTONE REMNANT.
Cretaceous beds of Shabarakh Usu.

B. A FOSSIL DEPOSIT AT ARDYN OBO, 1922.

THE FLAMING CLIFFS

This is one of the most picturesque spots that I have ever seen. From our tents, we looked down into a vast pink basin, studded with giant buttes like strange beasts, carved from sandstone. One of them we named the "dinosaur," for it resembles a huge *Brontosaurus* sitting on its haunches. There appear to be medieval castles with spires and turrets, brick-red in the evening light, colossal gateways, walls and ramparts. Caverns run deep into the rock and a labyrinth of ravines and gorges studded with fossil bones make a paradise for the palæontologist. One great sculptured wall we named the "Flaming Cliffs," for when seen in early morning or late afternoon sunlight it seemed to be a mass of glowing fire. On the floor of the basin, to the north, is an area of old dead sand-dunes covered by a miniature forest of stunted trees, which we first supposed were tamarisk, but which have been identified by Dr. Alfred Rehder, 1927, as *Salicornia herbacea*.

To the south, the rolling plain sweeps back to the Gurbun Saikhan, the last of the prominent uplifts of the Altai system. Gurbun Saikhan means "the Three Good Ones," and we found later that the name is well bestowed, for it is a fair land of rolling meadows and long grass among rounded peaks. Of the group, Baron Saikhan stands at the western end, Dunde Saikhan in the middle and the Dzun Saikhan at the east. They are essentially ranges of mountains separated by wide valleys, so that they appear as three major units. Like the other members of the Altai system they exhibit fault-block features in their construction.

NORTHWARD FROM SHABARAKH USU

The yurt which I had visited for information was a customs station between the province of Sain Noin Khan and that of Tushetu Khan, which we had just entered. The soldiers were very decent fellows and seemed unusually intelligent. They produced a guide who was supposed to know of a small trail which led northward through the basin to the Sair Usu trail. We hired the man and he slept that night with our Mongols. The next morning he led us down an almost impassable slope to the eastern side of the basin floor, which was thickly covered with sagebrush and playa-tufts. It was bad going, but at last we found a faint trail and continued on it for ten miles until it turned down into the Ongin River valley, which we were paralleling.

The terrain became more and more composed of soft sand covered with a heavy growth of low bushes and at last the cars could go no further. We were much discouraged for so much gasoline had been consumed that we doubted if enough were left to take us to Sair Usu should it be necessary to retrace our way and make another attempt.

THE "HUNDRED-MILE TENNIS COURT"

While I was debating the question, Granger and Berkey prospected ahead along the very edge of the bluff which dropped off to the river valley. They found less sand there and an absence of woody growth, and we decided to push on. Within two miles the terrain became harder, and we found that the vast plain had been swept clear of sand, leaving a smooth gravel surface. Hardly a trace of vegetation broke the gray expanse, which we named the "Hundred-Mile Tennis Court."

This was one of the smoothest and longest-continued level stretches seen anywhere in Mongolia. For about sixty miles the difference in elevation amounted to only five hundred and fifty feet, and there were areas where for ten miles the total variation was not more than one hundred feet, with no local irregularity of more than ten feet. Apparently the area was as level as a floor, but the whole plain rose gently northward at the rate of about ten feet per mile. During almost the entire northward run we followed the Ongin River, on the eastern side of its valley. It was a wide trench carved out of the plain to a depth of fifty feet, and as the shallow river was split into numerous branches there was much green grass and many bushes in the valley bottom.

The last forty miles of the day's run were as delightful as the first part had been discouraging, and we sped along at twenty-five miles an hour. One or two small groups of yurts were pitched on the edge of the river valley, but we passed them without a pause, leaving frightened and wondering Mongols to stare after the apparitions that had suddenly appeared in their midst. Doubtless none of them had even heard of an automobile, and I would give much to know what were their thoughts about us.

ONGIN GOL-IN-SUMU

We camped that night on a green meadow within the valley near the lamasery "Ongin Gol-in-Sumu." It was a large establishment, with hundreds of lamas and novitiates, who literally swarmed about our tents and cars. They seemed of a rather better class than the usual priests and some of them had fairly intelligent faces. Also, they appeared to be under strict discipline, and the youngsters were sent scurrying back to their lessons when their instructors deemed that they had seen enough.

The buildings themselves were not so picturesque upon nearer view, for many of them were of gray brick. A large temple of wood was being constructed by Chinese carpenters, who do all the temple building in Mongolia. The Mongols never attempt work of this sort themselves.

THE SAIR USU TRAIL

The lamas told us that our caravan had passed that way ten days earlier,

and that the Sair Usu trail was only thirty or forty miles away; also they gave us the cheering prospect of good going. We did find the trail hard and smooth, although it soon turned away from the Ongin River valley and climbed up and down steep hills composed of Jurassic sandstones and conglomerates. The country was very desert-like and we saw only a few yurts, in some of the larger valleys where there was a little vegetation. We reached the Sair Usu trail just forty-seven miles from the Ongin Gol lamasery. It seemed certain now that there would be no serious difficulty in making the run to Kalgan, for the trail was wide and well-traveled.

As I have remarked before, this was the road which officials used in making visits from China to Urga, Uliassutai, Kobdo and other parts of Mongolia during the Manchu régime. We found wells at an average of ten miles apart, and the water was clear and cold although slightly alkaline. At several places the ruins of small Chinese mud houses were still to be seen; doubtless these were official stopping-places when the road was in use during the Empire.

We had hoped to find other sedimentary basins in this part of the Gobi, but it soon became evident that we were in an area of igneous rock formations of Jurassic age. Some of it was exceedingly complex and the geologists had a very busy time solving the puzzles, as we made only infrequent stops. We covered one hundred and twelve miles that day—the longest run of the summer. As I look back upon it and realize what the uncomplaining Berkey and Morris endured, I am decidedly contrite. They have remarked, 1927, concerning it:

"Nevertheless, the geologic route section was kept fairly true. It is a terrific task to unravel more than a hundred miles of such structure in a working day. The geologist finds himself completely exhausted, and even dreams of underground structure, of strata and fossils, bathyliths, roof-pendants and ancient metamorphic revolutions, until the sun rises again on another day of geologic puzzles. One must try it to appreciate in full the effort that must be made to keep the story straight."[1]

SAIR USU

The remainder of the run was uneventful. In mid-afternoon we sighted a half-dozen mud huts, partly in ruins, and a small temple and ruins of a larger one, in a sandy basin beside two wells. Such was Sair Usu. In the days of the Empire it must have been a station of considerable importance, for it is at the intersections of main trails to Urga, Uliassutai and Kobdo. A little to one side of the nearest well stood the blue tent of our caravan and the long lines of boxes with the American flag in the center. Merin and his Mongols welcomed us joyously; the day was September 5 and we had kept our appointment.

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, pp. v–xxxi, 1–475.

Merin had arrived late the previous evening, without incident save the loss of one camel. We had seen its skinned carcass beside the trail, for the Mongols always exhibit the skin as evidence that the animal has really died and has not been sold. I always allowed the caravan leader to keep the money obtained from the sale of the camel and sheep skins, and the camel's wool which they collected during the summer, except that used by the palæontologists for packing fossils.

I spent all next day taking out the necessary food and gasoline for the run of five hundred and thirty-six miles to Kalgan, also, in transferring to the caravan the specimens collected and every item of equipment that could be spared, for we should not see the camels again. Late the previous night a big Chinese caravan had come in and camped a short distance away. The members of this caravan were on their way to Kobdo and Chinese Turkestan, carrying cloth, tea, tobacco and boots, to be bartered for wool, hides, furs and ponies. The visitors could give us little news of China, since they had been away two months, but they did tell us about the trail.

FIRST PALÆOZOIC STRATA IN PLACE

We left Sair Usu on September 7. I gave Merin final instructions to go straight down the trail to Kalgan and to reach there not later than October 20. Actually, he arrived ten days earlier than that date with all his specimens and camels in good condition. The trail took us southeast, up and down a series of low hills which afforded rock outcrops that gave Berkey and Morris a very busy time. Eleven miles from Sair Usu they discovered a cliff of fossiliferous limestone just south of the road, and a hasty inspection revealed a fauna indicating Palæozoic age. Subsequently it was determined as Dinantian (Mississippian). The geologists were able to collect only a few specimens and to note the locality as an important one for future investigations, which Morris made the following year. This was the first time that determinable Palæozoic strata were discovered in place. Only one other piece of Palæozoic rock, a fragment from the alluvial slopes at the foot of the Gurbun Saikhan, had been found up to this time.

MONGOLS' FEAR OF STRANGERS

That day we saw once more grim evidence that for the preceding three years a human life in Mongolia had been worth less than that of a sheep. At one place, Shackelford and I, in the leading car, drove over to two yurts to inquire about the road. We saw three men leap on ponies and ride to the hills, leaving four women. Two were very old, one was about fifty and the fourth was a really beautiful girl of eighteen or twenty. They had spread a clean white felt before the yurt and were lined up, trembling and kowtowing. As

we stopped the car a few feet away, the girl ran to get another felt, and one of the women rushed inside to bring milk and tea. In a few moments our Mongol explained that we were Americans and would not hurt them. They had never heard of America, nor of any white men except Russians. When I gave them a few trinkets they were pitifully pleased. They clung to one another, crying, and explained that they had expected to be killed instantly. They had wanted to run away, but the men had taken all the horses, and we came so fast that they could not hide. A short time later we stopped at another yurt, and one of the two women there had an attack of violent nausea, from sheer fright, when she saw Granger and Colgate. There were a large number of yurts in the less arid parts of this region, and several small temples. Such places have only a few resident caretakers, but lamas come to these temples for two or three months during each year to conduct services.

DIFFICULTIES OF THE TRAIL

At one bad sand-wash there was an accident to the pinion gear of one of the heavily loaded cars, which delayed us for an afternoon and morning, but a new part was substituted and we went merrily forward again. Hard work developed almost immediately, because the trail led us into a dry, sandy river-bed between high cliffs, where shoveling was the order of the day. Our eyes were gladdened, however, by the sight of several good-sized elm trees growing in the dry stream bottom. Here their roots penetrated deeply enough to find water even in the seasons of greatest drought. None of us realized how much we missed trees until we heard the soothing rustle of the wind among the leaves.

After the bad going we came out into a great depression where the trail was hard and smooth. This basin was one of the most arid stretches that I have ever seen, a rolling gravel floor with only the scantiest vegetation and hardly a trace of animal life. The deathlike monotony of the bare, gray desert was most depressing, and the expedition lapsed into silence. For forty miles there was no sign of a human being; then we discovered a Chinese caravan from Kweihwating en route to Uliassutai. The men of the caravan told us of a well some ten miles farther on, but if later we had not happened to meet two Mongols on horseback, we never should have found it. The Mongols never had seen an automobile and were badly frightened at first, but, unlike most natives, stood their ground while we drove up to them. I asked one to ride in the car and guide us to the well. It was amusing to watch the play of emotions reflected in his face; first astonishment and negation, then hesitation, next extreme desire, and finally surpassing courage as he acquiesced.

His companion led his pony to the well, which was two miles off the trail. Two yurts were near-by and I sent one of our Mongols to buy a sheep. He

found only one old man, frightened nearly to death, who said that all the others had fled to the hills at our approach and had driven their sheep with them. Even though we left presents with the old man, the Mongols returned during the night and quietly packed up their yurts; when we awoke the only indications that they had ever been there were the dead embers of an argul fire.

After a morning run on the same gravel plain, we came to a sand-swept surface, where with every mile the cars labored more heavily. They could barely make headway on the trail, which was only faintly indicated in the loose sand, but at last we descended a moderate slope into a great basin where the terrain was again clean hard gravel.

ARDYN OBO

A line of cliffs bulked faintly against the sky, and as we neared it, red, gray and yellow bands showed on its bold face. My car was far in advance of the fleet and I drew up at the base of the bluff to await the others. I told the servants to prepare tiffin while the scientists gave the exposure a hasty inspection. Berkey, Morris and I prospected the red basal sediments unsuccessfully, but Shackelford, with the instinct of a pointer dog for game, worked along the overlying gray and yellow sands. He returned with his pockets full of bones and teeth, among which carnivores and rhinoceros were easily identifiable. Granger had stopped at a low rounded knoll beside the trail, and brought fragments of titanothere as his contribution.

It was quite evident that we must give the exposure a more thorough inspection, and I told the boys to make camp. The bluff extends east and west for many miles, but the direction changes abruptly to almost north and south at the prominent corner where the trail passes and we had camped. At this point the actual face of the escarpment measures three hundred feet, and the slopes below it add another two hundred feet. It stands out like a cape on a seacoast. The impression is strengthened when one climbs to the top and looks over the vast basin below. On the very point of the bluff the Mongols had built a large obo, or prayer monument. Many obos are mere piles of stones on the summit of a hill near the trail, but others are more elaborately constructed. Each stone means a prayer to Buddha, and the Mongols never fail to add a contribution to the pile when passing such a monument.

We found that the bluff was named Ardyn Obo and was well known to the natives for many miles. It was appropriate that this name should be given to the formation. The obo itself was solidly built and elaborately decorated with silk hatas, torn bits of cloth, sticks and roughly shaped wooden spears and knives. The Mongol word *ardyn*[1] means "jewels," referring to

[1] Spelled *Irdin* for the locality south of Iren Dabasu.

PLAT

THE FLAMING CLIFFS AT SHABARAKH USU WHERE THE DINOSAUR EGGS WERE DISCOVERED, 1925

the highly polished pebbles of quartz and chalcedony which are found in the upper sandstones of the formation.

THE ARDYN OBO FORMATION

The face of the bluff has virtually no vegetation, and the strata are well exposed. They consist essentially of three members, red clays below, gray clays and yellow sands in the middle and cross-bedded sands and gravels above. It is only the middle member that is fossil-bearing. The sediments evidently were all water-borne, as the cross-bedding indicates, and the stream action must have been vigorous; this is also shown by the fossils. No associated skeletons were discovered, only skulls and scattered bones, many of them being water-worn. While the deposit is not prolific in fossils, nevertheless it yielded some good specimens which identified the formation as of Lower Oligocene age.

PROSPECTING FOR FOSSILS AT ARDYN OBO

On our first day the afternoon's prospecting netted quick results. Everyone took a different section. I had a pocket full of turtle shell, which was abundant, but as I worked around a corner I saw Shackelford on his knees scratching at the earth with his pick. He said that he had found some large bones, which I identified as rhinoceros. Berkey joined us, and together we traced the bed of a stream which millions of years ago had run upon the surface. We were looking at a cross section of it and could see the successive layers of heavy gravel, small pebbles, sand and fine silt. It was easy to follow the course, and near the spot where Shackelford had found the rhino bones we could see that there was an abrupt drop. Below was a heterogeneous mass of pebbles and large stones. This indicated a pool at the base of a small waterfall or rapid. An animal that died in the upper reaches of the stream very probably would be carried into the pool, sink to the bottom, and be covered with silt. Therefore, Berkey suggested that we dig into the bank at this point. In less than five minutes I had located a jaw and, directly below it, a large skull. Then Granger appeared upon the scene and put an abrupt stop to my excavations. Meanwhile Shackelford had discovered a beautiful rhinoceros jaw, partly embedded in the surface but in plain sight, and a set of teeth of a small artiodactyl.

Instead of spending one day at this great bluff we remained three, because every time that Granger started to remove a skull he discovered another a few inches from it. The ancient pool proved to be a veritable mine of fossils, but we simply had to get away if we were not to expose ourselves to serious danger from early snowstorms. It was difficult to leave a beautiful skull which actually could be seen, but it might take weeks to exhaust the possibilities of the deposit.

Granger spent almost every daylight hour in the "Hole," as we called this particular spot on the side of the bluff, even having his tiffin sent up to him. At first he allowed human visitors, but one after another we did something that incurred his palæontological displeasure, and were ordered off the premises. Finally only our camp dog, Mushka, and the two pet choughs remained to keep him company. On the second day Mushka tipped over a tray of bones and was banished. The choughs behaved themselves fairly well and amused him greatly, for they were continually getting their glossy feathers so covered with flour paste that they could hardly fly. But at last one of the birds committed an unpardonable sin. Granger removed an almost perfect skull which had only a tiny piece of bone gone from one side. After nearly an hour's search he discovered the missing fragment and carefully pasted it in position. The instant his back was turned one of the crows hopped on the specimen, picked off the bone and swallowed it. Granger never forgave the bird, and even after he returned to Peking he was still grumbling about it as he packed the skull for shipment to New York.

I spent a good deal of time searching for fossils along the sides of the bluff, which extends many miles to the west. It was fascinating to wander up and down this "cross section of the ages." One could trace the courses of many stream sediments, almost all of them productive of fossils. Turtle shells were abundant, and we found remains of a huge tortoise, *Testudo insolitus*.

FOSSIL FAUNA OF THE ARDYN OBO FORMATION

The fossil fauna of the Ardyn Obo formation which we obtained in our three days' stay was limited but interesting. Most important were the skulls of the aquatic "rhinoceros," *Cadurcotherium ardynense*, the extreme evolutionary stage in the family Amynodontidæ. A small perissodactyl representing a new genus and species, *Ardynia præcox*, was represented by teeth and jaw fragments, and an interesting carnivore, *Cynodictis*, was discovered; also two genera of Artiodactyla, *Eumeryx* and *Schizotherium*, were represented by fragments. In 1923 we spent a week at this locality, and a more complete collection was made, so that the relationship of the fauna could be determined. Doctor Matthew believed that it is somewhat older than the Hsanda Gol formation and remarked, 1923, concerning the fauna that "Its nearest geographic affinities . . . are with western Europe, not with the United States."[1]

AN EAGLE'S NEST

On a rocky ledge just under the rim of the bluff I discovered an eagle's

[1] Matthew, W. D., and Granger, Walter. 1923. "The Fauna of the Ardyn Obo Formation." *Amer. Mus. Novitates*, No. 98, pp. 1–5; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 17, pp. 1–5, 1926.

nest—a great pile of sticks and branches which must have been carried a long distance, since we had seen no wood for miles. Near the nest were the remains of at least twenty antelopes, some of them being full-grown bucks, and the bones of kangaroo rats and other small desert animals were scattered over the hillside. A pair of duck-hawks which lived high up among the rocks probably were responsible for much of the damage to the smaller mammals.

THE APPROACH OF WINTER

I was extremely anxious to leave Mongolia, because of the danger of early winter storms. A heavy snow, which might come any day, would obscure the trail and keep us in camp until it melted. Then the terrain would be sticky mud in the depressions, and very difficult for the cars to negotiate. During the winter, cars can run without great difficulty, because the ground is solidly frozen, and the dry snow is swept from much of the desert, lying only in patches and drifts, but the late spring and early winter storms make motor travel well-nigh impossible, for the ground is warm and soft and the snow melts after a few days; usually before the terrain has dried another blizzard arrives.

The other members of the Expedition were at a loss to understand my anxiety because they did not realize the sudden changes of Mongolian weather. On September 12 the day was so warm that it was uncomfortable to sit in the tents, and at night we slept under light blankets; the thermometer registered 78° F. at midnight. Shortly after daylight it began to rain and the temperature dropped thirty degrees in a few hours. The Expedition donned its fur clothes, and the men began to realize that I had not been wrong in predicting the early advent of winter. Cold and bitter wind followed us back to Kalgan.

CHAPTER XVI

RETURN TO PEKING

THE DEPARTURE FROM ARDYN OBO

We broke camp at Ardyn Obo on September 13, 1922, shortly after noon. I had waited as long as possible, but even then Granger was still working on his specimens and carried the latest skull in his lap for the remainder of the day; he would not trust it to a box in the car until the paste bandages had dried sufficiently to form a firm, hard shell. After a few miles the trail climbed out of the Ardyn Obo basin and led up and down bare, hard-rock hills, which looked like the solidified billows of an ocean in a mighty storm. About twenty-five miles from Ardyn Obo we reached a very large Chinese temple, Gatun Bologai, which was occupied by Mongol lamas. It has no element of Mongol architecture, and up to 1911, when the Chinese were expelled from Mongolia, it probably had only Chinese inmates. The following year, 1923, we made use of the temple as a depository for food and gasoline. We pitched our camp September 13, 1922, ten miles southeast of the temple in a dry stream-bed where there were several good-sized elm trees. That night we had a blazing log fire, the first since leaving the forests of Sain Noin Khan.

THE JISU HONGUER FORMATION

Various kinds of bad going were encountered during the next morning, but in the afternoon we sped at thirty miles an hour over a great rolling plain. At the western end of it the geologists were thrown into a fever of excitement by the discovery of a great deposit of Permian limestone, richly fossiliferous. These beds formed a part of Dr. A. W. Grabau's predicted Mongolian geosyncline or "earth trough" which ran through central Asia eastward to the Pacific at Vladivostok. During at least two long geological periods it had been filled with marine waters. Concerning this discovery, Doctor Grabau writes: "It may be mentioned in passing that the Mongolian geosyncline in Dinantian and Permian times was outlined upon the maps purely because of the requirements of palæogeography, and without positive knowledge of the existence of

marine strata of this age in the region included in the geosyncline. Subsequent discovery, by the Third Asiatic Expedition, of both Dinantian and Permian strata with rich marine faunas in the very heart of the region thus outlined, demonstrated the soundness of the principles on which the construction of these maps is based."

The formation was designated Jisu Honguer, after the Mongol name for the district. The geologists could spend only two hours at this spot during the first trip, but they visited it again both in 1923 and 1925, making a large collection of the invertebrate fossils. The formation occupies a narrow strip bordered by fault contacts between the granite hills on the south and the graywacke series on the north. Farther eastward, the entire series passes under sediments which carry a rich fauna of later Eocene vertebrates.

THE SHARA MURUN FOSSIL BEDS

Eighteen miles to the eastward from Jisu Honguer, Granger and I, who were in the leading car, saw an escarpment where characteristic Tertiary beds were exposed. Descending to the lowland we came to an area in which deposits of red, greenish, and purple clays were prominent. The nearest exposure is only a few yards from the road, and, after directing the other cars to proceed slowly along the trail, we walked over to the low ridge. Both of us immediately found fossils in great abundance. Bones of rhinoceros type were spread over the ground and we saw at once that it was one of the most remarkable fossil deposits that we had discovered in all Mongolia. We selected some of the best specimens from which to identify the locality and were on our way back to the car when I saw a long bone partially buried in the earth. I called to Granger and in five minutes it was evident that here was a complete titanothere jaw with all the teeth in position. A real problem presented itself. Should we leave it, or spend the day or two that it would require to paste and bandage it properly? At any moment a snowstorm might tie up the expedition for days and I decided that it was unwise to stop.

Granger said that he could remove one complete tooth row which would serve for positive identification of the specimen and for comparison with the American titanotheres. It would fall apart in many pieces, no doubt, but he could fit them together at the laboratory in Peking. The next half-hour saw an example of heroic methods in fossil dentistry. Every fiber of Granger's collector's soul rebelled against the crime he was committing upon a priceless specimen, and his groans as each tooth was extracted indicated as great pain as the titanothere itself would have experienced had it been alive. When the thing was done we carefully covered the remainder of the jaw, took bearings upon its location, and went on to join the men who were impatiently awaiting us. Farther along the trail we passed several other exposures, which evidently

were a part of the same formation and indicated a vast region for future investigations. Granger was convinced, and correctly so, that this was a western extension of the Irdin Manha basin, in which we had found the first fossils on the Kalgan-Urga road. The formation was formally designated the Shara Murun, and proved to be of Eocene age, but slightly younger than the Irdin Manha. The red-banded beds at the base probably are the equivalent of the Irdin Manha.

ULA USU AND BARON SOG-IN-SUMU

Beyond the exposure the trail climbed to the top of the eastern edge of the basin. A short distance from the escarpment, in a small hollow, is a well containing clear, delicious water. It is known to the Mongols as Ula Usu, the "Well of the Mountain Waters."

For eleven miles eastward we drove over the level Gobi erosion plane to the opposite side of the broad mesa, where a prominent escarpment exposed a few hundred feet of white and reddish sands and clays. Not far from the trail stood a small temple, Baron Sog-in-Sumu. Although we stopped for only a few minutes, we found the priests most cordial in their welcome. In future years this temple became a valuable storage depot for our gasoline and specimens.

THE SHARA MURUN RIVER

From the temple we could look eastward across the broad valley of the Shara Murun River. The stream was shallow and easily crossed in 1922, but in 1925 it was swollen by heavy fall rains and became a formidable obstacle to the motor cars. The valley is about three hundred feet deep. Our direction on the eastern side changed to S. 80° E., the trail taking us over another great erosion plain, more rolling than that of Shara Murun.

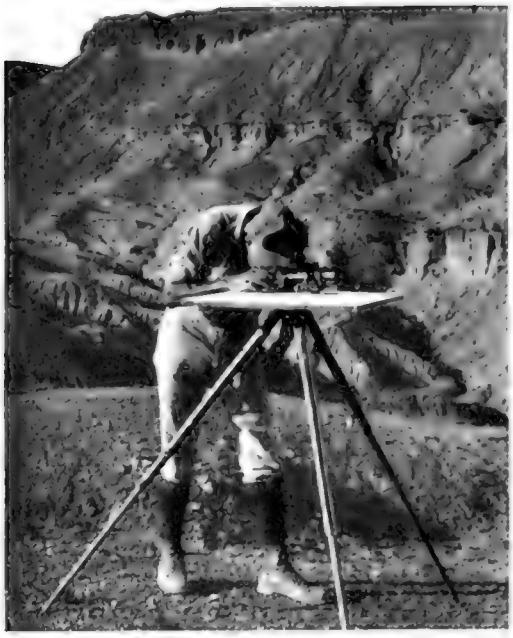
A SNOWSTORM

On the morning of September 15, we had a foretaste of what I had been expecting every day. Rain and bitter wind sent us into our heaviest clothes, but it was impossible to keep either dry or warm. Hour by hour the weather grew colder and the rain changed first to sleet, then to snow. We lost our way a dozen times and finally had to draw up in the shelter of a bank in a dry riverbed. The snow came so thickly that it was impossible to see. I had about decided to camp when the storm abruptly ceased. The ground was still warm, so the snow soon melted and again it was possible to find the tiny trail. We camped near half a dozen yurts under the lee of a great rock spine over which the wind howled like a charge of Mongolian demons. The entire Expedition ate dinner wearing fur gloves, and we immediately sought warmth in our sleeping-bags.

PLATE XLV.

MONGOL HERDERS CARRYING LASSOES AT A DESERT WELL.

PLATE XLVI.



A. FREDERICK MORRIS AT THE PLANE-TABLE.
Oshih Basin, 1923.

B. MCKENZIE YOUNG WITH A MOUNTAIN SHEEP HEAD.
[illegible]

C. PROFESSOR HENRY FAIRFIELD OSBORN.
Holding the newly found duplicate tooth of the coryphodont, *Eudinoceras mongoliensis*. Irdin Manha, 1923.

D. J. B. SHACKELFORD WITH TWO MARMOTS IN SPRING PELAGE.
Five Antelope Camp, 1922.

CHINESE FRONTIER IN THE SOUTHERN GRASSLANDS

During the next day's travel, the country gradually changed into the typical southern Mongolian grasslands and we came to the outlying fields cultivated by Chinese farmers. They showed at first as isolated patches with strips of unbroken ground between, but a few miles farther south the fields appeared as a continuous line of standing or half-harvested grain. Except for the blue-clad Chinese peasants and the occasional mud-walled houses, we might have been looking across the grain fields of North Dakota.

In a single day we had come from the arid reaches of a semi-desert into the midst of a prosperous farming community. On the very outskirts of cultivation we saw a few Chahar Mongols, but as the fields increased these disappeared and none but Chinese remained. Just as the white men in America drove the Indians farther west, so the Chinese are pushing the Mongols out of all the southern grasslands of Mongolia. The Mongols are essentially a pastoral people. By nature they are not agricultural, and centuries of tradition have made them nomads. They seem not to be able to change their life even as they see themselves driven out of their finest grazing lands by the steady encroachment of the Chinese farmers. Year by year areas of new land are opened for settlement by the Chinese. On the Kalgan-Urga trail, the most distant cultivated locality in 1918 was seventy miles northwest of Kalgan; in 1930 it had been advanced to one hundred and fifteen miles. Soon all of the Inner Mongolian grasslands will have been occupied and the northward extension of cultivation brought to a halt at the edge of the desert. Although irrigation undoubtedly could be carried on to advantage in many parts of the Gobi, I believe that it will be many years before this is attempted, unless the much-talked-of railroad to Urga materializes. The soil of the grasslands appears to be deep and rich. There is an abundance of rainfall, and ponds are frequent. Millet, wheat, oats, barley, flax and potatoes are the principal crops.

The last hundred miles through the area of cultivation were difficult. Nowhere in our entire exploration in the Gobi had we encountered such difficult traveling. More damage was done to the motors during the first day up the Wan Ch'uan Pass, and in the last two days of our return trip, than in all the other three thousand miles. Long trains of Chinese carts pass on their way to Kalgan, and their spike-studded wheels work havoc with any road. There were mud and deep ruts in the valleys and rocks and ruts on the hills.

Late in the afternoon of September 18, we reached Miao T'an, the Chinese village thirty-four miles north of Kalgan, which we had left just five months before. It was a great day for us. We had a dinner of Chinese food at the inn and from the proprietor learned much of the political news of China. We were dirty and travel-worn but happy, for we knew that the Expedition had been an unqualified success.

THE RETURN TO KALGAN

I engaged a cart to take the heavy baggage to Kalgan so that our cars might go down the Pass as light as possible. It was well that we had no excess weight, for I have never known the Pass to be in worse condition. It was a nightmare for motors and our average speed was only four miles an hour. We had made so close an estimate on our gasoline supply that all the cars reached Anderson, Meyer and Company's compound except Colgate's. A can of gasoline had to be sent to bring that one car the last half mile, from its stopping place just inside the city gate.

Larsen was in Kalgan and we had much to tell him. His first question was: "Did you get the wild ass you were chasing when we left you on the crest of the hill?" The first thing we asked him was how soon we could get a bath. Berkey and Morris stayed with Larsen; the rest of us went to the British-American Tobacco Company's mess, where the doors are always open to travelers from the interior.

Our efforts to meet the requirements of civilization were almost pathetic. Each one of us had some article of adornment which he had been cherishing for the home-coming. Shackelford appeared in a wonderful blue shirt. I had a purple necktie, while Granger and Colgate each produced a new pair of shoes. When we came into the dining-room for tea, where half a dozen visitors had assembled to welcome us, we all felt decidedly uncomfortable.

SUMMARY OF THE 1922 SEASON'S WORK

We left Kalgan for Peking on September 21, exactly five months from the day we started for the great plateau to test a theory. The day following our arrival at Peking, the Expedition staff gathered in the great drawing-room of our headquarters to compose a cable to the American Museum of Natural History, which would announce the principal results of the summer's work. I suppose no moment in an explorer's life is more satisfying than that when he makes public for the first time the story of the months during which he has been lost to the civilized world—if that long isolation has produced results which justify the expense and human effort!

In perspective

Another interesting experience is the gradual gaining of a new perspective on what he has done. Although none of our staff ever lost his enthusiasm for the work, still the very closeness to it, and the continued discovery of new facts of vast scientific importance, at times tended to make it almost commonplace; the daily fatigue of overworked muscles and nerves, the discomfort and frequent hardships, sometimes made one wonder if it was all worth while. But in a comfortable home, with rested brains and bodies, with the work done and

the strain and anxiety ended, we could begin to understand, as a whole, the significance of what had been accomplished during the summer.

Roughly summarizing the results, we realized that the work had resulted in an almost overwhelming amount of new information in geology, palæontology and geography. In spite of the pessimistic predictions before our start, we had opened a new world to science; in the rocks of Mongolia we had before us a splendid record of earth history and an equally wonderful record of past life. Our new geological formations fitted admirably into the general geological column of the world. The understanding of vertebrate evolution and dispersal would be immeasurably widened by our palæontological discoveries.

The traverse

We had traveled from the seacoast straight across Mongolia to the forests of the northern edge, up to the Arctic Divide, and could visualize the country as though it were a relief map. Coming from the seacoast, the low sand and silt plains stretch right up to the base of the mountains through which the Nan K'ou Pass gives access to a new level nearly two thousand feet higher. Crossing this smaller and higher plain we had come to a new barrier, the Pacific Divide, topped by the outermost rampart of the Great Wall; a barrier five thousand feet above the level of the sea. This is part of the southern edge of the Mongolian plateau, which is one of the great interior basins of central Asia.

A thousand miles northward across the plateau stands the Arctic Divide separating the drainage into Siberia from the waters that flow south into the desert. Between the Pacific and Arctic divides lies a great cradle-like sag, descending gradually to the depression at Iren Dabasu, where the elevation is not more than three thousand feet above sea-level. From all sides the land slopes to the interior. This large basin-like region has not a simple floor, but it is a complex of smaller basins, each one of which is smooth and flat, and separated from contiguous basins by rolling hills or semi-mountainous ridges. It is these open stretches of level ground in the secondary basins that are called "gobi" by the Mongols.

We had found that wind, and to some extent rain-wash erosion, had swept the lighter material from the surface, and that the Gobi is essentially a "rock desert," with sand-dune belts only in restricted areas. Day after day we had traveled over the nearly barren surface of rock.

The geology

The geologists had learned that the geologic formations of Mongolia consist of two grand divisions: one an exceedingly complex series of ancient rocks carrying the story back to the very dawn of geologic history; the other

a simple series of sediments recording the last chapter. Between this ancient series and the later one, a long interval is lost.

We had discovered a gigantic granite bathylith, possibly the most extensive in the world, underlying the later sediments and frequently coming to the surface. We had learned that since Jurassic times Mongolia has been continuously dry land, with no period of submergence beneath the sea; that across the plateau had extended a great geosyncline as predicted by Grabau; that there was no evidence of glaciation other than that of a strictly alpine type which had not reached the plains; that there is reason to believe that climatic cycles or fluctuations have occurred in Mongolia from late pre-Cambrian up to the present time. The geological column of Mongolia had been partially filled in by the identification of many geological systems. Due to the indefatigable efforts of Professors Berkey and Morris, we had obtained the longest detailed topographic route map and continuous geologic sections ever made on reconnaissance. From the standpoint of geologic science alone, the Expedition had been a conspicuous success.

The palæontology

Palæontologically, our results were quite as significant. In a vast region, the life history of which was absolutely unknown, we had discovered some of the richest fossil fields of the earth. In this first season's work twelve vertebrate fossil-bearing formations had been identified and named, beginning with the oldest, as follows:

Cretaceous Period: The Ondai Sair, Oshih (Ashile), Iren Dabasu, and the Wan Ch'uan formations.

Upper (?) Cretaceous Period: The Djadochta formation.

Eocene Period: The Irdin Manha and Shara Murun formations.

Oligocene Period: The Ardyn Obo, Houldjin, and Hsanda Gol formations.

Miocene Period: The Loh formation.

Pliocene Period: The Hung Kureh formation.

Nearly two thousand specimens had been obtained from these formations, representing several new families and subfamilies and a great many new genera and species. These indicated that the Mongolian fossil fauna would fall into three categories: First, animals that originated in Asia and never strayed outside its limits; second, animals that originated in Asia and migrated to America or Europe; third, animals that originated in America and migrated to Asia.

The zoölogy

The zoölogical collections numbered several thousand mammals, which,

together with those that I had obtained in 1919, gave us an unrivaled series from north and central Mongolia. Subsequent study showed that most of the desert and grassland species had a very wide distribution, as might be expected in a region where there are few natural barriers. The ranges of some forms were extended for many hundreds of miles beyond previous records.

The photography

Mr. Shackelford had obtained twenty thousand feet of film and many still photographs, showing every phase of the Expedition's work, as well as a complete story of Mongol life. Such a permanent record of a vanishing culture is of enormous value.

The motor transport

The fact that we had been able to use motors successfully in this remote region immediately brought commercial results. We had hardly returned before fur traders and wool buyers arrived to ask how they could reach outlying stations with automobiles. In a short time it became evident that our Expedition had opened central and western Mongolia to motor transport. As a matter of fact, within three years a hundred cars were running where not one had been before.

PLANS FOR 1923

At the staff meeting we projected a complete program for the following year's work. It was evident that we must concentrate on palæontology in order to take advantage of the great fossil fields which had been discovered. This could be done only by asking the Museum to send us three additional expert fossil collectors. Doctor Berkey found it necessary to return to New York at once, to take up his work at Columbia University, but Professor Morris was to remain in Peking and spend the winter writing, and studying Russian. On the next Expedition he would devote himself to special areas where the geology needed further study.

In November, Doctor Granger would proceed to Wanhsien, Szechwan, to complete the collections which he had made there during the winter of 1921–1922. I would remain in Peking to make the necessary preparations for the coming summer's exploration. Mr. Shackelford would return to New York to arrange and edit the twenty thousand feet of motion-picture film. Mr. Colgate was to continue his trip around the world, of which the expedition to Mongolia had been a part.

In addition to the three extra palæontological collectors, it would be necessary for the next Expedition to include two motor experts to handle the transportation. Since we would cover virtually the same region and make the

next summer one of intensive work, it was deemed advisable not to take Mr. Shackelford, the photographer.

We discussed most carefully the relative palæontological importance of the various fossil fields, and made a paper plan of the amount of time which could be profitably devoted to each. Our estimates were so accurate that with one exception we were able to follow the schedule almost to a week.

All our equipment, including the motors, was brought back to Peking for renovation. Each car was completely "taken down" and overhauled. We were amazed to find that even after the grueling travel most of the car-parts showed little wear, and in only one or two instances were replacements necessary. It was a wonderful record for the Dodge Brothers automobiles.

SAFE RETURN OF THE CARAVAN

On October 10, I received word that the caravan had reached Chap Ser, but was afraid to proceed to Kalgan because of the brigands. Bayard Colgate and his cousin, Gilbert, who had joined him in Peking, volunteered to escort them through the dangerous territory. This they did without incident. The caravan had arrived ten days before the stipulated date, and Merin and the others were given a month's pay as bonus for their excellent work. I purchased a new yurt, flour, millet and other necessities, and sent them back with the camels to spend the winter near Chap Ser, a hundred miles north of Kalgan. The animals were thin and tired after their summer's travel, and Mongolia offers but poor feed during the winter; nevertheless, it appeared best to keep the camels, as it was impossible to sell them to advantage. The winter's transport was just beginning, and all caravans wished to start with fat, untired camels.

The collections were repacked in Peking and shipped to New York by water. They reached the Museum without the loss of a single box, and with every specimen in as good condition as when it had been removed from the rock in the Gobi Desert, thirteen thousand miles away.

FOSSIL PITS OF YEN-CHING-KOU

On his journey up the Yangtze River to Wanhsien, Granger had the usual experience of being continually fired on by brigands and soldiers. His whole winter was prevented from being monotonous by the inter-provincial war which is always in progress on the upper river. He did much more than palæontological work, for his presence in the village of Yen-ching-kou calmed and assured the inhabitants to such an extent that few of them left their homes, even when others fled to the hills. Yen-ching-kou is only twenty miles from Wanhsien, a city of considerable importance. Granger camped in a temple and carried on his work by buying specimens from the natives. He writes of the peculiar conditions of the deposit as follows:

"The fossils at Yen-ching-kou occur in pits, distributed along a great limestone ridge some thirty or forty miles in length and rising above our camp over two hundred feet. These pits are the result of the dissolving action of water on limestone, and some of them have a depth of one hundred feet or more. They are of varying sizes, averaging say six feet in diameter, and are filled with a yellowish and reddish mud, which is, I take it, disintegrated limestone. The fossils are found embedded in the mud at varying depths, usually below twenty feet. A crude windlass is rigged up over the pit, and the mud dug out and hauled to the surface in scoop-shaped baskets. At fifty feet it is dark in the pit, and the work is done by the light of a tiny oil-wick. It is fossil-collecting under the most adverse conditions imaginable.

"The excavation of the fossils has been going on for a long time—possibly some generations—and it is a considerable business. Digging is done only in the winter months.

"One has to be let down with a rope around his waist and with two or three men at the windlass. The natives climb up and down the rope hand over hand, but it requires practice and agility to do this. You'd be shy one palæontologist if I tried it!"[1]

Until Dr. J. G. Andersson began his splendid work with the Geological Survey of China, knowledge of the palæontology of China rested almost entirely upon the work of Schlosser.[2] All Schlosser's material was purchased in drug-shops and consisted of teeth and fragments of bones, without locality information. Thus, when Andersson began to discover fossils *in situ* he had a virtually untouched field before him. From his work and that of Schlosser, there is evidence of at least two distinct faunas in north China, probably separated by the Tsingling Mountains of Shensi.

To the north is the so-called *Hipparion* fauna of Pliocene age, characterized by an abundance of horses. To the south is what we have named the *Stegodon* fauna, for the remains of these primitive elephants are common.

During the three winters which Doctor Granger spent at Yen-ching-kou, he made a splendid collection, which was studied by Dr. W. D. Matthew, and comprises genera of the following orders: Primates, 2, *Bunopithecus* and *Rhinopithecus;* Carnivora, 7; Rodents, 2; Proboscidea, 1; Perissodactyla, 3; Artiodactyla, 7.

Regarding the affinities of the fauna Doctor Matthew, 1923, remarked:

"The above list is remarkable, as a cave or fissure fauna, for the scarcity of rodents (other than *Rhizomys*) and small carnivora. While the remains

[1] Andrews, Roy Chapman. 1922. "Politics and Paleontology," *Asia Magazine*, XXII, No. 5, May, p. 363.

[2] Schlosser, Max. 1903. "Die fossilen Säugethiere Chinas nebst einer Odontographie der recenten Antilopen," *Abh. Math.-Physik. Kl. k. bayer, Akad. Wiss.*, XXII, pp. 1–221.

of large animals are abundant and varied, the bamboo-rat is the only rodent, except for a single hare jaw, and no small mustelids or viverrids appear. It is no less remarkable that no trace of Equidæ is found in it, nor of camels, giraffes, typical Canidæ or machærodonts. This, coupled with the abundance of tapirs and deer, may point to a heavily forested condition. The abundance of *Stegodon*, the entire absence of *Elephas*, and the presence of *Chalicotherium* are the only observed indications of Pliocene age; for the most part the fauna appears to be quite closely related to modern species and might well be considered Pleistocene. The faunal affinities appear to be principally Chinese, partly Malayan, not much Indian; there is nothing especially suggestive of North American or of Siberian affinity. A more careful comparison and identification of the whole fauna, especially of the smaller ruminants, might show a clearer differentiation from the modern species than we have observed in this preliminary study, but could hardly alter materially the geographic and environmental affinities of the fauna. It is such a fauna as one might expect to find in the valleys of southwestern China at any time before the appearance of civilized man, and under climatic conditions similar to those now prevalent. The effect of the clearing and cultivation of the valleys and the lower slopes of the hills by man has been, broadly speaking, to drive the smaller animals to the mountains and to exterminate the larger ones. Some of the extinct types have left relatives, more or less distant, in the jungles of southeastern Asia, more resistant to human encroachment than the Chinese hills. But the tapir, rhinoceros, gaur and *Stegodon* of the Yen-ching-kou fauna, although their nearest existing relatives are of tropical habitat, do not necessarily indicate a warmer Pliocene climate in China. They may quite well have been species adapted to a temperate climate, such as is more definitely indicated by the geographic affinities of the remainder of the fauna."[1]

[1] Matthew, W. D., and Granger, Walter. 1923. "New Fossil Mammals from the Pliocene of Sze-Chuan, China." *Bull. Amer. Mus. Nat. Hist.*, XLVIII, Art. xvii, pp. 397–398; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 15, pp. 563–598, 1926.

CHAPTER XVII

DINOSAURS AT IREN DABASU

STAFF OF THE 1923 EXPEDITION

My urgent request to the President of the American Museum for three additional expert fossil collectors to accompany us on the 1923 Expedition met with an immediate response. Messrs. George Olsen, Peter Kaisen and Albert Johnson were selected. The first two had been on the Museum's field and laboratory staff for many years; the last had worked with Mr. Barnum Brown, collecting dinosaurs for several seasons in Alberta, Canada.

To handle the motors, I was fortunate in obtaining the services of Mr. J. McKenzie Young, of the U. S. Marine Corps, who was appointed Chief of Motor Transport; he had Mr. C. Vance Johnson for assistant. Both men were expert motor engineers and I knew that this important branch of the Expedition would be in competent hands.

The native staff remained the same as that of the preceding year, except that our mess "boy," Kan Chuen-pao, or "Buckshot," had been promoted to be a palæontological assistant to Doctor Granger. He had demonstrated such ability and interest in handling fossils at Yen-ching-kou, during the winter, that Granger realized we were losing real talent in keeping him as a mess boy. His judgment was amply confirmed, for "Buckshot" became one of the most valuable men we have ever had. Another young Chinese, Liu Hsi-ku, was added to the staff as a mechanical assistant. Later, he, too, graduated into fossil work, and with "Buckshot" was sent to the American Museum at the end of the summer for a year's laboratory training.

BACK TO MONGOLIA

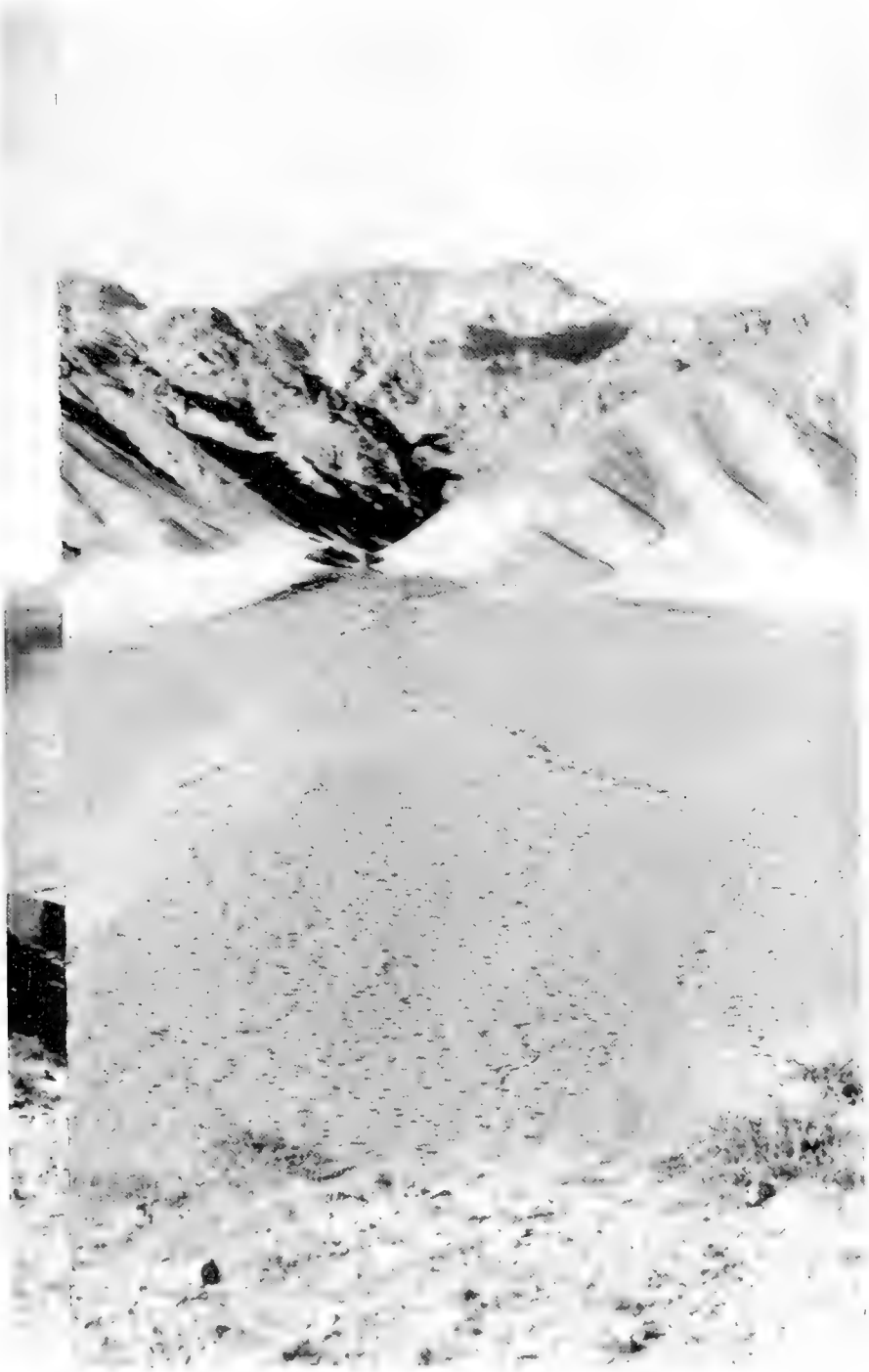
As our first investigation was to be in the Iren Dabasu basin, two hundred and sixty miles from Kalgan, I did not send the caravan away until April 2. The staff left Peking April 17, 1923, the date of our departure the former year. I hoped to strike the fortnight of fine weather which usually marks the beginning of the Mongolian spring, and to get well at work before the return of cold

weather about the seventh of May. We were a few days too early, however, and found the summits of the hills about Kalgan white with new-fallen snow. Mr. Larsen arrived from Urga late in the same afternoon and reported that his motor had crossed the last hundred miles on the plateau with the greatest difficulty, because of the soft snow which formed a mass of gluelike mud.

I decided to wait a few days until the terrain improved. Moreover, Mr. Larsen intended to return to Urga immediately, with a car full of silver dollars, and he was very anxious to travel with us for the sake of safety. A week earlier two Russian motors had been stopped by Chinese soldier brigands, dressed in uniform. The passengers had lost a valuable cargo of furs and all their personal belongings, even being stripped of the clothes they wore. One man was killed. Several caravans also had been attacked by bandits during the past month. All the robberies had occurred in the district just north of Kalgan, which is under the control of the Tutung of Chahar. His efforts at maintaining the safety of travelers in the area of Chinese cultivation were as futile as those of other officials throughout China. Every few weeks several brigands would be brought to Kalgan by soldiers, taken to the dry river-bed which runs through the center of the city, and shot. Sometimes they caught real bandits but just as often innocent peasants were executed. The "trial" was an empty formality.

On April 19, two days after our arrival in Kalgan, we left for the great plateau. Our passports were inspected at the barrier where Mr. Charles Coltman had been murdered by Chinese soldiers during the winter. Just a year before he had accompanied us to Urga, and a wave of sadness swept over me as I realized that the friend with whom I had lighted so many camp-fires on the Mongolian plains never would travel those trails again. At the summit of the Pass we halted to look back over the vast complex of shimmering badlands through which we had made our way. There, we bade good-bye to China and turned to the far-flung reaches of Mongolia beyond the wall. Mongolia, with the romance of a glorious tradition through which move the shadowy forms of Ghengis Khan and his world-conquering barbarians! Mongolia, a land of painted deserts dancing in mirage; of limitless grassy plains and nameless snow-capped peaks; of untracked forests and roaring streams! Mongolia, a land of mystery, of paradox and promise!

The first night we spent at the little Chinese inn of Miao T'an, thirty-four miles from Kalgan, for I had no wish to camp in the brigand-infested hills. There was a company of soldiers quartered in the village, and when we were about to start in the morning, their commander sent an officer to say that for our "safety" he had despatched a dozen men beyond us on the road. He ended by remarking naïvely, "Please don't shoot my soldiers!" I assured him that we would be careful whom we killed, but our guard were taking no



ARIZONA TORII, SHOWING THE MAIN PEAK, BEAR CANYON, AND PART OF AN ALLUVIAL FAN

chances. When we passed them about five miles beyond the inn they sounded a bugle and drew up beside the road with a flag prominently displayed for purposes of identification. As a matter of fact, we did see some twenty mounted brigands before we were out of the cultivated area. They lined the hills on both sides of the road, but our cars, bristling with rifles, did not impress them favorably and they left us severely alone.

Those of us who had been in Mongolia before were astonished at the extension of cultivation during the last year. A new tract had been opened by the Chinese Government, and tilled lands now reached to Chap Ser, one hundred miles from Kalgan. At Hallong Ossu, near Chap Ser, there was a Swedish mission station in charge of Rev. Joel Eriksson. In 1927 it had to remove farther into the grasslands, for the Mongols had all been driven out by Chinese encroachment.

SCENES ALONG THE KALGAN-URGA ROAD

I never have seen the Kalgan-Urga road as fine as it was that spring. Because of the previous two years of war, cart traffic had ceased and the ruts had all been worn down by weathering and the padded feet of camels. When we crossed the previous year, the plains were deserted. Monasteries lay in ruins; yurts were absent, and no flocks of sheep or goats drifted up the sheltered valleys. If a solitary Mongol sighted the cars, he fled like a frightened animal. With the kaleidoscopic changes which come to these countries of the Orient, the land had assumed the normal aspects of peace in one short year. Yurts clustered near almost every well, like giant beehives; herds fed quietly on the grasslands, and picturesque caravans of majestic camels passed us on the road, carrying loads of skins to Kalgan or merchandise northward to Urga, the city of the Living Buddha. Winter furs were coming down from Urga on every automobile, and crowds of Chinese merchants were going up. Ten to fourteen men, and as many bedrolls, were the usual load for a five-passenger Dodge Brothers car. Each one paid "Mex. $50," the equivalent of fifty Mexican dollars, then about $25 gold, for a chance to ride, and it was his affair to find a seat. As many as possible squeezed into the tonneau, and the less fortunate ones half lay on the bedding, which was piled on the running boards level with the top of the doors, their legs sticking out in all directions. At a little distance an auto thus loaded appeared like an enormous spider. The springs of the cars were blocked with wood and rubber, yet it is a miracle how they stood the test.

We reached the first telegraph station at P'ang Kiang before dark. It had been a run of one hundred and forty-three miles from Miao T'an, the longest day's trip the whole fleet had ever made. I shot two antelope for meat, and our camp that night was a joyous one. Near the telegraph station a

large mud-walled inn had been newly erected, and preparations were being made for heavy motor traffic during the summer.

THE WHEREABOUTS OF OUR CARAVAN

We had confidently expected to find our caravan awaiting us at Iren Dabasu, but it was not there. I knew that Merin had taken a trail east of the main road, because it was safer and offered better grazing for the camels, yet Mongols who had traveled by the same way reported no sign of our caravan. It was easily identifiable, for the boxes were peculiar in shape and the big lead camel always bore the American flag. I was greatly worried, for brigands were so numerous in that region that I feared the caravan had been captured and driven off into the desert. While food, which the boxes contained, would be of little interest to bandits, the camels themselves could be disposed of easily enough, and the three thousand gallons of gasoline sold in small lots to motor stations along the main road.

But canny old Merin had not been caught, after all, and one evening a car roared into camp with the word that our camels were twenty miles away at the Lung Ku Shan (Dragon Bone Hill), and would be in next day. The Mongols arrived gleeful as children to be safely in camp with us. Merin said that when he left Chap Ser he heard that there were bandits ahead of him watching the trail. Therefore, he slipped off into the desert, traveling at night from well to well and camping during the day in sheltered hollows where he could not easily be seen. His weather-tanned face beamed as he told how he had played hide-and-seek with the brigands and yet had filled the stomachs of his camels with some of the best grazing they had had all winter. Two of the weakest camels had died on the way to our camp, but the others were in fairly good condition and only needed an abundance of food to make them fit.

FOOD AND CHARACTERISTICS OF A MONGOLIAN CAMEL

Although Iren Dabasu is a desolate area of sand-dunes and sagebrush, it offers the most delectable food from a camel's standpoint. Sagebrush, thorny bushes, or almost anything as long as it is sufficiently dry and salty, offers him the maximum of gastronomic entertainment. He is such an extraordinary example of adaptation to environment that I never tired watching the herd at rest or on the march.

The Mongolian camel is able to pick enough nourishment from the well-nigh invisible vegetation on a gravel plain to keep him alive, his great, flat foot-pads carry him over loose sand as easily as though he were on snowshoes, and his ability to go for long periods without water makes him an invaluable asset to the desert nomads. Wherever possible the Mongols watered our camels every two days, but once or twice they had to go five days without a drink.

But the camel is such a highly specialized beast that he is helpless away from his desert and cannot adapt himself to changed conditions. While his long legs and flat pads carry him over the sand at the steady pace of two and one half miles per hour, if he encounters mud or slippery ground he simply gives up and would die in his tracks without making an effort to save himself. His feet have no grip and slide in every direction; then his long legs are a distinct disadvantage, for they spread out, and once down it is difficult for him to rise. Rocky terrain cuts and tears his feet and he stands helplessly, uttering the most doleful wails.

He is as timid as a mouse and as delicate as a child. He catches cold very easily, and if his long neck hair is cut or his winter's coat is pulled off too soon, a sudden change in temperature will put him on the sick list for days. The natives believe that when a camel sheds his hair, which he does at the end of June or in July, he is unusually weak. At that time he is virtually naked. If he is kept at work during the shedding process he will not grow as good a coat during the summer. In the Gobi it is difficult to find suitable packing material for fossils, but the camels solved this problem for us by furnishing their shed hair.

A camel's temper is uncertain, and as a rule he likes neither the odor nor the appearance of a white man. He will kick and bite viciously, but even worse is he when he manifests his displeasure by spitting. A green mass of half-digested evil-smelling vegetation is discharged in a spray. It requires days to remove the taint from one's body or clothes, and "once spit upon twice shy" was an adage which was brought home to every member of the Expedition by sad experience. He can become accustomed to eating grain and dry straw, but his natural food is the vegetation of the desert. Unlike the single-humped dromedary, the Bactrian camel is a cold-weather beast, and work in the heat rapidly saps his strength. He will not graze at night, and for this reason, even in the winter, caravans usually rest during the day, start late in the afternoon, and travel until two or three o'clock in the morning. At night the animals are brought to the camp and are tied, kneeling, by their nose-strings, head to head on either side of a long rope.

We loaded our camels only up to four hundred pounds. This is the maximum weight that they can carry on a long trip, although for a short distance five or even six hundred pounds is not too much. The strongest are the short-legged, heavy-bodied type. The long-legged beasts never seem to have as much endurance as the others. Those which are bred in a very sandy region have wider foot-pads, but these are also thinner and more easily cut by travel over rough ground.

We had only gelded camels in our caravan. The bulls begin to rut in December and at that time are very dangerous. Only an experienced man can

handle a rutting bull. Once a bull followed my motor for five miles. It happened to be in heavy going where we could not make speed, and the enraged animal almost overtook us. Several times I thought it would be necessary to shoot him, for had he caught us he certainly would have done his best to annihilate the entire party. The period of gestation is thirteen months and calves are usually dropped in January. The cow then is unfit for work, and as she attends the calf for more than a year, she does not bear young oftener than once in three years.

I always allowed the caravan leader to have for himself, as a perquisite of his position, such of the camel hair as we did not need for packing specimens. As the wool is worth about one hundred dollars (Mex.) a *picul* (133 lbs.), and as each camel sheds six or eight pounds, it was a lucrative job for a Mongol.

FOSSIL COLLECTING AT IREN DABASU

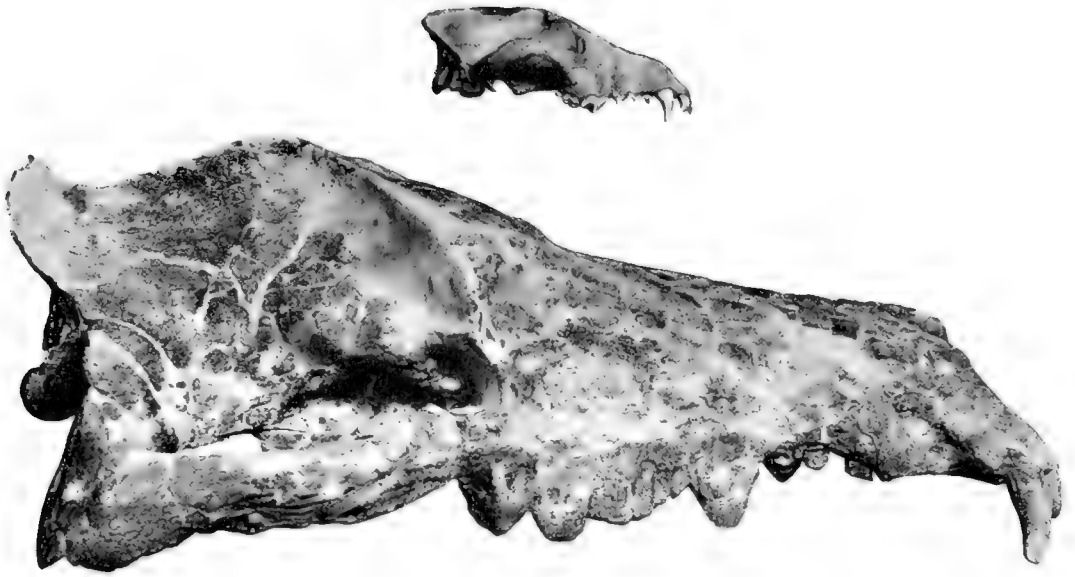
At Iren Dabasu we camped on the same spot where our tents had stood the previous year. The desolate surroundings were even less attractive than usual, for the entire central Gobi was parched from ten well-nigh rainless months. Even the light showers, which in a few hours seem to completely change the face of the desert, had been absent during the autumn, and there had been but little winter's snow. The salt marsh lay white and stark without a trace of water; the sand hillocks and the basin floor were untinged with green; it was a dreadful monotony of brown and yellow.

The morning after our arrival, the three new men, Kaisen, Olsen and Johnson, set out eagerly with picks and collecting sacks to have their initial experience in the fossil fields of Mongolia. Morris, Granger, Young and I drove westward on a trip of exploration, to see if we could locate additional exposures. Eight miles from camp we saw the familiar gray-white strata and stopped to prospect. Almost immediately teeth and fragments of bone were found scattered over the surface in a half-dozen places. Granger discovered a huge femur, half exposed by the action of wind and water and frost which were wearing away the rock particle by particle.

As I walked over the ridge that day I had the same feelings which I suppose inspire every prospector for gold. It was a likely-looking place, and at any moment I might discover a discoloration in the rock or a tiny fragment of bone which would give the clue to a mine of palæontological wealth. Without a doubt there were hundreds of bones lying just beneath the surface. But where? If only my eyes could pierce that baffling surface and get a glimpse of what lay concealed!

It is well-nigh hopeless to dig for fossils unless there are definite indications of their presence. There must be some sign, a piece of bone "running in," or something upon which to fasten hope. Otherwise one might dig and dig

PLATE XLVIII.



A. SKULL OF *Andrewsarchus* AND OF AN AMERICAN TIMBER WOLF.

B. RESTORATION OF *Andrewsarchus* UNDER THE DIRECTION OF HENRY FAIRFIELD OSBORN, BY MRS. E. R. FULDA.

A [illegible]
[illegible]

B. *Entelodon*, A GIANT PIG-LIKE ANIMAL.
Painted by Charles R. Knight

and miss the greatest treasures by a few feet or even inches. Of course, one finds bones which have been broken by the action of weathering into a hundred fragments and which have no connection with other parts of the skeleton beneath the surface. These disappointments come most frequently in fossils deposited in an old stream-bed, where swift water has rolled and broken them before they could be buried in sediment and preserved.

The Houldjin gravels, where remains of *Baluchitherium* are abundant, are such a deposit. Time after time I have felt my blood thrill with excitement at sight of a projecting bone, thinking that it might mean that a skeleton lay underneath, but after carefully working away the rock or earth only a useless fragment would be uncovered. My feelings about the Houldjin gravels, and all similar stream deposits, are a standing joke in the Expedition.

I am hardly philosophical enough for a palæontological collector; disappointments and successes send me too easily into the blackest depths or to the pinnacle of happiness, and particularly I cannot curb my impatience sufficiently when a specimen has been found. Walter Granger, or any of the other trained men, are content to work away grain by grain with a camel's hair brush, waiting for the specimen to develop as they go down. Theirs is admittedly the proper way to proceed, but pick and shovel methods, which at least give quick results, come more naturally to my restless spirit. Perhaps a complete skeleton or a priceless skull lies below that bit of projecting bone, and I simply cannot wait for days to know. Therefore, whenever one of the men is engaged upon the delicate operation of removing a specimen, the Chief Palæontologist issues an ultimatum to the Leader of the Expedition, "Thou shalt not approach this sacred spot unless thy pick is left behind."

THE IREN DABASU "QUARRIES" AND THEIR FAUNA

In our brief survey of the Cretaceous ridge west of Iren Dabasu, we saw enough to warrant sending over three men for a careful inspection. Each one of them immediately discovered important fossils, which in every case developed into "quarries." Albert Johnson's proved to be the richest. His keen eyes were attracted by a fragment of bone not more than three inches long. By following this clew he gradually exposed such a great deposit that for a month he and Kaisen worked continually in a single spot. The fossils lay only a foot or two below the surface, but were so completely covered that except for the three-inch bit which gave away the secret, their presence would have been unsuspected.

In this deposit, bones of both flesh-eating and herbivorous dinosaurs, of several species and of many individuals, were piled one upon the other in a heterogeneous mass. They appeared to have been subjected to a swirling action when they were deposited, which led us to believe that this spot had been a

backwater or eddy at the edge of the lake or stream. When the dinosaurs died, their bodies drifted into this bayou, where they came to rest, the flesh decomposed, and the skeletons sank into the soft mud, eventually to be fossilized.

On the shores of the ancient stream or lake grew a lush vegetation, for the dinosaurs' bones are of the bipedal, duck-bill iguanodont type which wallowed in the mud along the edges of watercourses where the plants were soft and succulent. Since this type was an herbivorous feeder and without means of defense, it must have been a prey of the carnivorous or flesh-eating dinosaurs which were contemporaneous. We found some bones of the carnivores mixed with the iguanodont remains. Very probably these fierce creatures, in their struggles with the duck-bill dinosaurs, had been drawn into the water and drowned, their bones becoming fossilized with those of their victims. Presumably the lake or stream was surrounded by more or less open, savannah-like country, since we discovered small dinosaurs of the running, plains type like *Ornithomimus*. There were also crocodiles, turtles of the *Trionyx* type, and a few pelecypod shells.

During the Age of Reptiles, with conditions particularly favorable to their development and with nothing except natural causes to check their increase, the extent of the reptilian life which swarmed in this region baffles imagination. To-day, this nightmare world of the past is gone. In its place lie the silent, wind-swept ridges of the Gobi Desert, parched and blistering under the summer's sun, during the winter an area of arctic desolation.

Not far from the quarry which Johnson opened, Kaisen and Olsen each found deposits where fossils were in abundance. Olsen discovered the complete hind limb of a large carnivorous dinosaur. The leg lay doubled up just as the great reptile had died millions of years ago. The remainder of the skeleton had weathered out and broken into fragments, or, in those far-distant days, other flesh-eating dinosaurs may have torn the carcass asunder and dragged portions of it away.

In Johnson's quarry the bones lay on top of each other in a heterogeneous mass. Perhaps he would uncover the end of a limb only to find that it ran beneath another bone which would have to be removed before the first could be prepared. It was like a game of jackstraws, and only men with years of experience and infinite patience could have done the work at all. First, the earth was swept away with a whisk broom; then with a camel's hair brush as the fossils were approached. Curved awls were used to loosen the matrix. If the bone was soft and crumbly it was hardened with a solution of gum arabic, and Japanese rice-paper was stippled on every inch; thus the tiny fragments were held in place. After this initial treatment, the specimen was bandaged with strips of burlap soaked in flour paste. When the paste had dried, more of the earth or rock was dug away, the fossil turned over and the operations repeated

until the entire bone had been enclosed in a hard shell. This kept it intact during the long journey to the laboratories of the Museum. Some specimens were so closely cemented together that they could not be separated in the field, and large blocks of bones and matrix were removed entire.

One bed of red sandy clay near the Johnson quarry, the highest fossil-bearing horizon yet found in the Iren Dabasu basin, contained abundant fragments of smooth curved plates. We were at a loss to identify these at the time, but at the end of the season, when the discovery of undoubted dinosaur eggs had been made at Shabarakh Usu, Granger began to suspect that these also represented dinosaur eggshells. Specimens were sent, together with those from Shabarakh Usu, to Professor Victor Van Straelen, Université Libre, Brussels, Belgium, who confirmed the diagnosis, and in part remarks: "Thus there are striking differences between the eggs of Shabarakh Usu and those of Iren Dabasu. The first-named cannot be correlated with any of the actually known eggs, either living or fossil. The second-named have a structure similar to that of the supposed eggs of *Hypselosaurus priscus*, the dinosaurian of Rognac, which themselves have a structure that partakes of the characters of both the palæognathic and the neognathic birds. But the Iren Dabasu eggs differ essentially from the Rognac eggs in the shape of the aëriferous canals."[1]

The shells vary in size and probably represent different types of dinosaurs. The larger eggs are considerably larger and less elongate than those found at Shabarakh Usu. This is the second place in Mongolia where dinosaur eggs have been discovered.

THE HOULDJIN GRAVELS AND THEIR FAUNA

While the other palæontologists were working in the Cretaceous beds of Iren Dabasu, Granger and Morris made several trips to the Oligocene Houldjin gravels exposed at an escarpment six miles farther to the south. This is a rather thin capping of yellow, pebbly gravel lying on the Cretaceous, and is apparently only a remnant of a much more extensive formation. In 1928 this formation was traced in the west and named the Baron Sog formation. It is quite certainly the result of stream action, and the fossils are broken up and rounded as though they had been carried for some distance by swift-flowing water.

It was at this exposure that the first fossils in Mongolia were discovered by the Expedition. *Baluchitherium* fragments were abundant, but in only a few cases were they worthy of being saved. Teeth and bones representing the following genera were also collected: *Cœnopus* or *Præaceratherium*, *Cadurco-*

[1] Van Straelen, Victor. 1925. "The Microstructure of the Dinosaurian Egg-Shells from the Cretaceous Beds of Mongolia," *Amer. Mus. Novitates*, No. 173, May 27, p. 3; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 49, pp. 1–4, 1926.

therium, *Entelodon* and a large tortoise, *Testudo*. Dr. W. D. Matthew, who identified the specimens, stated that the "fauna is of Oligocene age but cannot be more exactly correlated until more completely known."[1]

AN EXPERIENCE WITH BRIGANDS

I remained at Iren Dabasu only two days, for considerable equipment had been left at Kalgan, which had arrived too late to go with the camels. Vance Johnson, Liu and I went back in two cars. On the way I had an amusing experience with brigands. My car was more than a mile in advance of Johnson's when we came to the spot, just below Chap Ser, where two Russian cars had been robbed a few weeks earlier. As I recognized the spot, I thought to myself, "I wonder if brigands would attempt to hold me up in this same place?" Hardly had the thought taken form in my mind when I saw the sun-flash of a gun barrel on the summit of a hill three hundred yards away. The head and shoulders of a single mounted horseman were just visible against the sky. In Mongolia and China only two kinds of natives have modern rifles —brigands and soldiers. As a matter of fact, they are virtually synonymous, for a soldier usually becomes a brigand when a favorable opportunity offers, and vice versa.

Undoubtedly, the horseman on the hilltop was a sentinel to give warning to others in the valley below. I had no mind to have him in such a position, whoever he might be, and drawing my revolver, I fired twice. The bullets must have come too close for comfort, although I did not attempt to hit him, for he instantly disappeared. A moment later, as my car topped the rim of the valley, I saw three mounted brigands at the bottom of the slope. It would have been difficult to turn the car and run without exposing myself to close-range shots, and, knowing that a Mongol pony never would stand against the charge of a motor car, I instantly decided to attack. The cut-out was open and, with a smooth down-hill stretch in front of me, the car roared down the slope at forty miles an hour. The expected happened! While the brigands were endeavoring to un-ship their rifles which were slung on their backs, their horses went into a series of leaps and bounds, madly bucking and rearing with fright, so that the men could hardly stay in their saddles. In a second the situation had changed! The only thing that the brigands wanted to do was to get away, and they fled in a panic. When last I saw them they were breaking all speed records on the other side of the valley.

[1] Matthew, W. D., and Granger, Walter. 1923. "The Fauna of the Houldjin Gravels," *Amer. Mus. Novitates*, No. 97, p. 1; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 16, pp. 1–6, 1926.

CHAPTER XVIII

IRDIN MANHA, SHARA MURUN AND ARDYN OBO

THE RETURN TO IREN DABASU

When I returned from Kalgan to Iren Dabasu I brought with me Colonel H. Dunlap,[1] Commandant of the U. S. Marine Guard Detachment, American Legation, Peking, and Lieutenant-Colonel Seth Williams. These two officers had done much toward equipping the Expedition, and we had planned to have them visit us before we started west. We reached camp on May 11, 1923, after an uneventful trip, and for a week the officers shot sand-grouse and antelope and watched the excavating, at both Johnson's and Olsen's quarries, which was well under way. They left us on May 18 to return to Peking, much to the regret of every member of the Expedition.

IRDIN MANHA IN 1923

The following day, May 19, we shifted camp to Irdin Manha, twenty-three miles south, leaving Johnson and Kaisen to carry on their work at Iren Dabasu. Our tents were pitched on the edge of the bluff, near a spring which bubbled out of a layer of Eocene clay. To the north and west we could look over the rim of the basin to the sculptured flanks of the great escarpment; to the south and east lay the flat reaches of the Gobi erosion plane as level as a gigantic polo field.

A TERRIFIC WINDSTORM

The day after our arrival at Irdin Manha we experienced one of the worst windstorms that I have ever seen in Mongolia. At two o'clock in the afternoon a full gale was raging, and every hour the wind increased. I went out at four o'clock to find Granger, but I could hardly stand against the blasts of sand and gravel which mutilated my hands and face until they bled. The basin below us was "smoking" as if from a prairie fire; the yellow blanket rolled

[1] In 1931, Brigadier General Dunlap was killed in France while gallantly attempting to rescue a peasant woman who had been buried in her cottage by a landslide.

and swayed, now and then parting for a moment to show a bit of vegetation on the floor, only to have the vista closed as a fresh wave of sediment swirled across to the escarpment's rim. In the tents we were almost buried in sand; beds, clothes, tables and chairs were thickly covered with a yellow layer.

This windstorm gave us an excellent demonstration of the methods by which the depression had been made. Great clouds of sand whirled and eddied over the edge of the escarpment; thus was the accumulated sediment carried out. The geologists believe it possible that a river started the excavation, but the enclosed basin must have been scoured out by the wind. Although small stream courses, dry most of the year, lead from the surrounding bluffs toward the salt marsh at Iren Dabasu and a certain amount of sediment must be transported by them into the basin, yet the depression does not fill. Only the wind could remove it, as we saw it doing in those gales, which continued for three weeks with only momentary lulls. It was impossible to work except at intervals, and then under the most trying circumstances. I drove to Iren Dabasu twice to see how Kaisen and Johnson were making out. They had stuck doggedly at it whenever there was an interval of comparative quiet, and had removed a great quantity of material.

THE SUBDIVISIONS OF THE IRDIN MANHA BEDS

Irdin Manha, which means "The Valley of the Jewels," takes its name from the brilliantly polished pebbles of jasper, chalcedony, agate, quartz and quartzite found in the Eocene sediments. It is interesting to note that the pebbles were already polished when they were laid down in the deposit during Eocene times, but whether this was a chemical or a sand-blast polish is uncertain. The formation is sharply divided into two members—one of red clays at the base, and the other of gray sandy clays, sands and gravels above. It was thought wise to give the name Arshanto to the lower member, reserving the term Irdin Manha for the upper gray division.

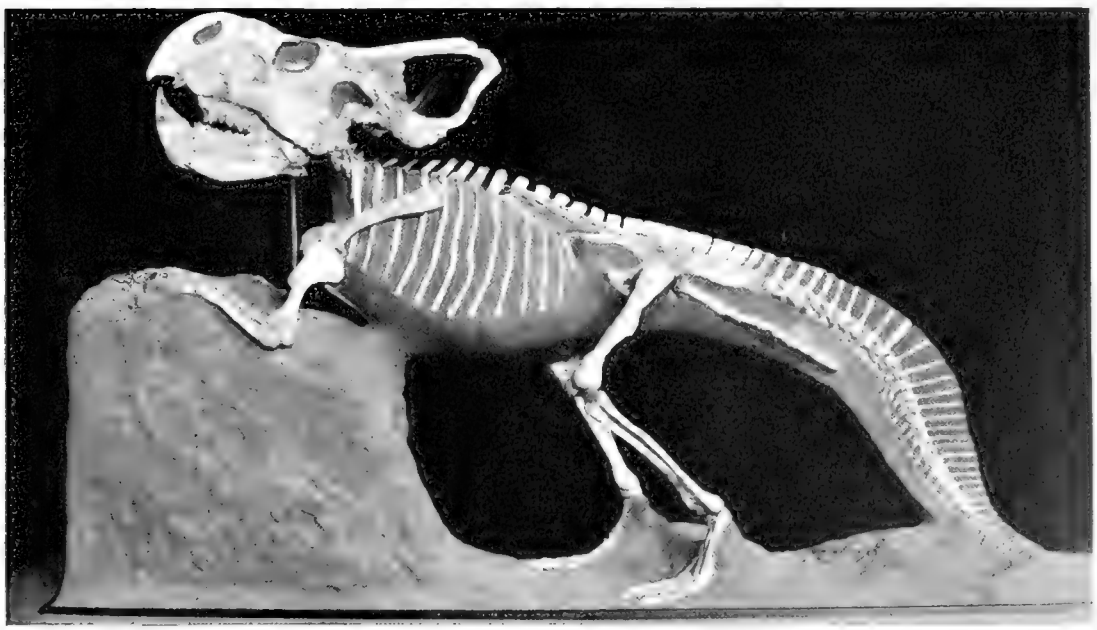
THE FOSSIL FAUNA OF THE IRDIN MANHA BEDS

Matthew and Granger, 1926, have described two primitive little perissodactyls from the Arshanto, but, although the beds are richly fossiliferous in certain places, the remains are usually fragmentary. A few limb bones were found intact, but no associated skeletons. Teeth, pieces of jaw and ends of limb bones were the most usual material, although some fine skulls, nearly complete, were discovered. These show definitely that the formation is of Upper Eocene age. We did not know until later that it was near where the Kalgan-Urga road cuts this deposit that the Russian explorer, Obruchev,[1]

[1] Obruchev, V. A. 1893. "Brief Geological Sketch of the Caravan Route from Kiakhta to Kalgan." *Bull. Imp. Russ. Geol. Surv.*, XXIX, pp. 347-390. St. Petersburg (Russian).

PLATE L.

A. RESTORATION OF *Protoceratops*.
On the nesting ground of Shabarakh Usu during the Cretaceous period, by Mrs. E. R. Fulda.



B. SKELETON OF *Protoceratops andrewsi* FROM SHABARAKH USU.
Mounted by Peter Kaisen, American Museum of Natural History.

A. SKULL OF *Protoceratops andrewsi* FROM SHABARAKH USU, 1923.

B. SKULL OF *Protoceratops andrewsi* PARTLY EXCAVATED AT SHABARAKH USU, 1923.

in 1892, collected the fragment of a "rhinoceros" jaw, which was the first and only fossil recorded from Mongolia, prior to the 1922–1930 work of the Central Asiatic Expeditions. Remains of lophiodonts were extraordinarily abundant, and it was possible to collect a handful of teeth in an hour, at almost any part of the exposure near camp. The entire absence of horses was a surprising feature of this and other early Tertiary faunas of Mongolia.

The day after our arrival, Granger went to a spot west of camp to relocate a large jaw which he had discovered the previous year. Near the same place he found a beautifully preserved titanothere jaw lying across a tiny wash; upon starting the excavation, the corresponding jaw came into view, lying palate up, with a complete tooth row. The skull was almost perfect and there was great rejoicing in camp. A half-hour later Granger found a second pair of jaws directly under the first, as well as another slightly broken skull. That night Olsen reported that he, too, had located a fine titanothere palate.

Our discovery of titanotheres in Mongolia was a personal triumph for Professor Osborn. Heretofore, titanotheres were known only from America, with the exception of a doubtful fragment from Austria. Just before I left New York, Professor Osborn said to me: "Make a careful search for titanotheres. I am convinced that you will find early types in Central Asia." We were so delighted with the discovery that I sent a cable to the Museum by a car which passed our camp en route to Kalgan.

Titanotheres are an extinct family of peculiar, hoofed mammals, which flourished in North America from the Lower Eocene to the close of the Lower Oligocene and were represented by nearly two hundred known species. The primitive Lower Eocene forms were hornless, but the climax of the group is represented in the Lower Oligocene by gigantic animals with a pair of transverse horns above the eyes. The Mongolian titanotheres show the most striking resemblances to the forms of corresponding horizons in North America. They demonstrate clearly that there must have been a land connection between Asia and America, which acted as a migration route.

During the three weeks which we spent at Irdin Manha, remains of twenty-six titanotheres were collected from this formation. By far the greater number belong to the species which Professor Osborn, 1925, named *Protitanotherium grangeri*, but other species and genera were represented, as follows: *Manteoceras? irdinensis*, *Metarhinus? mongoliensis*, *Telmatherium berkeyi*, *Dolichorhinus olseni*.

Granger had instructed Kaisen and Johnson to finish work in their quarries, for they were getting only duplicates, although much bone remained in sight. I sent Vance Johnson, one of the motor experts, into Miao T'an, with two tons of fossils to be stored at the Chinese inn until the end of the summer.

The afternoon of Johnson's return, "Buckshot" discovered the superb skull of a gigantic beast, which I believed to be a carnivore. The next day Granger dashed our hopes by pronouncing it to be that of a pig, *Entelodon*, which, because of its omnivorous habits, resembled a flesh-eater. However, Morris made a drawing of the skull *in situ;* this was forwarded to Doctor Matthew at the American Museum. When we returned from Mongolia, a letter was awaiting us, stating that my original supposition was correct, and that the specimen represented one of the primitive creodonts of the family *Mesonychidæ.*

Later it was named *Andrewsarchus mongoliensis* by Professor Osborn, who says that "the cranial and facial proportions of *Andrewsarchus* are remarkably similar to those of *Entelodon* of the Oligocene and of *Dinohyus* of the Lower Miocene of North America, doubtless because of similar omnivorous feeding habits." Professor Osborn further remarks:

"This is the largest terrestrial carnivore which has thus far been discovered in any part of the world. The cranium far surpasses in size that of the Alaskan brown bear, *Ursus gyas*, the largest living carnivore, which, when full-grown, weighs 1,500 pounds; in length and breadth of skull, *Andrewsarchus mongoliensis* is double *Ursus gyas* and treble the American wolf, *Canis occidentalis.* It is also treble the size of its American relative *Mesonyx obtusidens* from the Middle Eocene of Wyoming and double that of *Mesonyx* (*Harpagolestes*) *uintensis* from the Upper Eocene of northern Utah, Uinta B." Basing his estimates upon the skeletal restorations of *Mesonyx obtusidens* by Scott and of *Dromocyon vorax* by Wortman, Professor Osborn says:

"If *Andrewsarchus mongoliensis* was proportioned in the same manner as *Mesonyx obtusidens*, it had a length from the snout to the back of the pelvis of twelve feet six and a half inches, and a height from the ground to the shoulder or middle of the back of six feet two inches. Thus in round numbers it was three times the size of *Dromocyon vorax* or of *Mesonyx obtusidens* of the Middle Eocene of Wyoming, Bridger formation."[1]

In addition to the specimens I have mentioned, our collections from Irdin Manha contained representatives of the Carnivora, Rodentia, Insectivora, Perissodactyla, Artiodactyla and Amblypoda. The Irdin Manha formation was prospected for several miles both east and west, but nowhere were the fossils so abundant as in the vicinity of our camp near the Kalgan-Urga trail. In the western part of the basin the escarpment breaks up and the exposures are limited to a number of rounded hillocks. On one of these I found the upper premolar tooth of an animal which Professor Osborn, 1924, identified as repre-

[1] Osborn, Henry Fairfield. 1925. "*Andrewsarchus*, Giant Mesonychid of Mongolia," *Amer. Mus. Novitates*, No. 146, pp. 1–5; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 34, pp. 1–5, 1926

senting the Amblypoda, an archaic order of ungulates. Except for *Coryphodon* of the Lower Eocene of France and England, no Amblypoda had hitherto been known in Eurasia, and their presence in Mongolia served as a new link with America. Diligent search revealed only this single premolar, but in September of 1923 Professor Osborn himself found another tooth, under circumstances which will be described later.

To the northeast, about seven miles from the road, the Gobi erosion plane breaks off into another broad undrained basin where there are excellent exposures, but few fossils. However, some thin beds of gray and red sandstone did yield a fragmentary collection of small lophiodonts, which appear to be quite unlike those from the typical Irdin Manha formation.

THE LIVING FAUNA AT IRDIN MANHA

While working on the face of the escarpment just west of camp, the men were annoyed by the brown pit-viper, *Agkistrodon halys intermedius*, which was present there in numbers. When the sun began to warm the rocks near noon, these extremely poisonous reptiles would crawl out from their nests among the rocks and prevent the fossil collectors from becoming drowsy over their work. Each man usually accounted for five or ten during the day.

On the plain in front of camp, gazelles were numerous, and usually one or two herds were visible from the door of my tent. There was little difficulty in keeping the table well supplied with delicious meat. Several times, in the early morning, we saw wolves loping northward toward the edge of the basin, where they had dens in the face of the bluff, and they gave us some exciting races.

The taxidermists trapped industriously during all of our stay at this camp, and collected several hundred small mammals. At Iren Dabasu they caught a single specimen of a new rodent, *Ellobius orientalis*, which Dr. G. M. Allen remarks "not only extends the known range of the genus to the eastern part of the Mongolian plateau but constitutes its easternmost record."[1] The kangaroo rat, *Allactaga mongolica*, was extraordinarily abundant at Iren Dabasu, and in fact throughout the Gobi. It has a wide range and does not vary subspecifically in the desert proper. Doctor Allen said, "Among the specimens taken during May and early June there is a very striking preponderance of males. Thus, of the one hundred and seventeen skins taken in May, all but fifteen were males, indicating some difference in habits in the earlier part of the season; for in August the proportion is just reversed, with only five males to fourteen females."[2]

[1] Allen, Glover M. 1924. "Microtines Collected by the Asiatic Expeditions," *Amer. Mus. Novitates*, No. 133, p. 13; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 28, pp. 1–13, 1926.

[2] Allen, Glover M. 1925. "Jerboas from Mongolia," *Amer. Mus. Novitates*, No. 161, p. 1; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 42, pp. 1–6, 1926.

A beautiful three-toed jerboa, *Dipus sowerbyi*, was also fairly abundant, as were the sand-rats, *Meriones auceps* and *Meriones unguiculatus*. Of the giant sand-rats, *Rhombomys opimus nigrescens*, which we first discovered at Tsagan Nor, a single specimen was taken at Iren Dabasu, thus extending its range well to the east. We found no representatives of the conies, *Ochotona*, at Iren Dabasu, although they occur further to the west in exactly the same type of country. However, the black-tailed hare, *Lepus tolai tolai*, was plentiful.

The most interesting of all the birds were the sand-grouse, which were present at Iren Dabasu in great numbers. There were two or three small pools among the sand hillocks, and in the morning and afternoon thousands of sand-grouse came there to drink. It was a beautiful sight to see a flock sweep in, circle a few times, and settle almost as one bird. Their flight is exceedingly swift, and they furnish splendid shooting as well as food.

THE 1923 PASSPORTS FOR OUTER MONGOLIA

Mr. Larsen had undertaken to obtain our passports for Outer Mongolia from the authorities in Urga, who had promised me the previous year to give them without trouble, but he encountered great difficulty and there were continual delays before they were finally issued. On Monday, June 11, our passports for Outer Mongolia were brought from Urga by a Russian car, since our camp was close to the main Kalgan-Urga road. We spent the day packing the remaining fossils and writing letters, for this would be our last contact with the outer world until the end of the summer. Almost a ton of specimens, which had accumulated since our previous consignment, was taken to Miao T'an and stored at the telegraph station at Iren Dabasu. We also made ready for an early start the next day. The caravan had already gone westward, and we expected to join it at Ula Usu, near the Shara Murun River, where a great fossil deposit had been located the year before.

ON THE WAY TO ULA USU

We followed a faint path westward to the small Holostai temple, and then turned southward on a larger trail to the great Boltai Urtu monastery at the junction of the Sair Usu road. Just before reaching this point, Morris discovered another deposit of Permian strata containing invertebrates and spent about two hours making a rapid investigation. On the way from Holostai to Boltai Urtu we passed a Mongol encampment of half a dozen yurts. The inhabitants were thrown into a state of terror at sight of the motor cars and ourselves. After we had somewhat allayed their fears, they told us that none of them had ever before seen a white man or an automobile. This was most surprising as we were less than three hundred miles from Kalgan, although in a region between the main caravan trails.

Boltai Urtu temple is beautifully situated in a deep grassy basin. The lamas informed us that Merin had passed that way the day before, and had told them that we were coming. As a result there was no panic, and we had hundreds of priests crowding about us to inspect the cars. From the monastery our road led through the grasslands, where thousands of female antelope, *Procapra gutturosa*, were herding just prior to giving birth to their young. We saw about twenty thousand does but very few bucks. At this time of the year the bucks lead more or less isolated lives and are seldom found in herds of more than a dozen.

The river Shara Murun, at the time we arrived in 1922 and 1923, was only a thin stream of water flowing over a mud bed between low banks, and we crossed without much difficulty. A short distance from the rim of the western escarpment of the broad river valley stands the small Baron Sog monastery, which became a repository for specimens and gasoline of the expedition in 1923 and 1925. The lamas are an unusually pleasant lot and were always most willing to assist us in any way. A fine obo stands on the very edge of the bluff and is visible for a long distance. During our stay we saw elaborate services being performed at the obo. Such celebrations at the large obos all over Mongolia are annual affairs.

THE CAMP AT ULA USU

Our camp was close to the place where I had discovered a titanothere jaw the year before, and about a mile from the "Well of the Mountain Water." We arrived late in the afternoon, and the men could hardly control their impatience to inspect the new locality, which had appeared to be so rich on our previous visit, September, 1922. The tents were pitched on a low sandy terrace in the basin proper, near the edge of a deeper depression where the fossils are found.

THE SHARA MURUN BEDS

The upper part of the Shara Murun formation consists chiefly of white and light-gray sandstones in which there are areas of gravel and beds of brownish and gray clay. The lower member is almost entirely sandy clay, variegated in red, purple, brown and green layers. Underlying the Shara Murun beds is a hard red clay in which a few fossils were found. This appears to be a different formation and was named the Tukhum, from the broad lowland in which it is exposed. Although the Shara Murun seems to be conformable with the Irdin Manha farther to the east, the fossil content of the Shara Murun indicates that it is of somewhat later Eocene age than that of the Irdin Manha formation.

Doctor Spock[1] remarks: "During Eocene time when the Shara Murun

[1] Spock, L. Erskine, III, this Series. (MS. in preparation.)

and the overlying Ulan Gochu formations were being deposited the region was one of level flood plains, crossed by sluggish meandering streams and dotted with small lakes. The alternation of red and white sediments coupled with the abundance of gypsum leads to the hypothesis of a climate fluctuating between arid and comparatively moist conditions, a state of affairs which seems to have continued from the Cretaceous to the present all over the Gobi Desert."

A PARIAH DOG

The titanothere lower jaw, from which Granger collected the tooth row in great haste during one hour's halt at Ula Usu in September, 1922, was described by Professor Osborn, 1923, as *Protitanotherium mongoliense.* As it was the type of a new species, Granger wished to recover it on our return in 1923. He found the jaw with little difficulty and carefully pasted it with burlap. He left it *in situ* to dry, but during that time a pariah dog, which had been wandering about the neighborhood, was attracted by the wet flour paste and carried away the precious specimen. It is probably the first time that a bone millions of years old had furnished nourishment for a living animal! The same dog later damaged Albert Johnson's rhinoceros skeleton, and was making an attempt upon Olsen's titanothere skull when it was shot.

A FULL GALE IN THE DESERT

The weather at Ula Usu was worse than any that we had experienced in Mongolia. The afternoon following our arrival, a terrific storm ushered in two weeks of almost continual wind. The description which I wrote in my journal the next day is as follows:

"I was making the rounds of the diggings when the strong wind which had been blowing all morning increased to a full gale. The basin looked like the crater of a volcano. Yellow clouds rolled and eddied up from the floor to sweep across the plain in swirling wind-devils. To the north an ominous tawny bank advanced upon us at race-horse speed.

"I started into the basin to recall the men but almost instantly a thousand shrieking demons seemed to be pelting my face with sand and gravel. Breathing was difficult; seeing impossible. I stumbled over the rim of the basin onto the plain and tried to strike diagonally toward camp. It was like pushing into an unresisting yellow wall which gave and closed behind me as I advanced. Even the ground beneath my feet was invisible.

"In a few moments I realized that I was being carried far to the east of the tents. The only recourse was to turn into the wind until I found the rim of the basin again and crawl along it to the cut behind camp. With head completely enveloped in my coat, I fought the salvos of sand and gravel. I do not know how long it was—perhaps ten minutes, perhaps half an hour—before I

suddenly stumbled over the edge of the depression and rolled into a hollow. I lay there huddled against the wind trying to think. Suddenly forms took shape in the smother right beside me. I reached out and caught one of them by the leg.

"It proved to be Tserin, one of our Mongols, with Peter Kaisen. Pressing our mouths close against one another's ears we held a consultation. Tserin thought the tents were directly south of us; Peter and I had no idea where they were. I decided to trust the native's instinct, and clinging to each other we groped our way through the blinding murk. A few yards forward and a black object loomed before us. It was the cook tent, still standing, but threatening to tear in shreds at every blast. The mess tent was just beside it and we found our way inside. Lying on the floor with our faces buried in wet clothes we at least could breathe.

"One by one the men blew into camp, with the exception of Walter Granger. It was impossible to search for him, and I was not greatly worried since Walter had demonstrated many times that he could take care of himself in any emergency, and always had a way of turning up, smiling. But Buckshot, who worshiped Granger, was frantic with anxiety. I had to order him not to leave camp, else he would have dashed wildly out into the blasts of sand to search for his master. As Johnson remarked, 'The directions say take it' and we took it in whatever position we could be most comfortable.

"The gale continued for an hour and then dropped suddenly into a flat calm. Not a breath of wind stirred the flag which hung limply above my tent, whipped almost to ribbons. The silence was uncanny after the roar and rush of the storm.

"We were just crawling out of the mess tent when there was a joyous shout from Buckshot and we saw a brown figure coming into camp. It was exactly the color of the desert, but behind a broad grin was Walter Granger. When the storm broke he had fought his way to a partly excavated titanothere skull, to mark the spot for fear it would be lost in the shifting sand. He just reached it, but could go no farther and huddled into the deep pit with his face in a coat. He had been completely buried except for his head and well-nigh smothered, but the walls of the pit had given him a good deal of protection.

"We began to dig out the tents and empty the sand from our clothes and beds. Much of the Gobi Desert was in our belongings; it had sifted into even the tightest boxes. The cameras, rifles, pistols and field-glasses suffered most, for even their double cases could not keep them clean. We worked steadily for two hours 'shoveling out.' I sent a car to the well a mile away, and everyone had a bath and dressed in clean clothes. Dinner was being served when one of the men looked out to the north. There it was again; the same tawny cloud, but this time preceded by an enormous 'wind devil' which danced and swirled

across the plain like a thing of life. It was heading directly toward us and we all knew what it meant if it struck our camp. I shouted for all hands to weight the bottoms of the tents and pound in the pegs. Explosions of wrath were heard from every side, because we were so clean then and knew full well how dirty we would be in a moment.

"Meanwhile the sand spout continued to advance, now and then taking a side trip off the line to our camp, but invariably getting back again. Suddenly it gave birth to a whole litter of 'wind devils' which skipped blithely away as though pleased to be rid of a dominating parent.

"We awaited the inevitable, muttering curses. The attack came with a crash and a blast of gravel like exploding shrapnel. For five minutes it tore at the camp, like a wild thing trying to suck the tents and all our belongings into the whirling vortex above our heads. Then, repulsed at every point, it danced away across the plain, seeming to feel with its wraithlike yellow arms for easier prey.

"Every man had a place at the poles of his own tent. Granger and I had held ours down together, and in the calm which followed the first attack we looked at each other and burst out laughing. 'Great Gods! Am I as dirty as you are, Roy?' he asked. I assured him that he was, only more so. When he looked at himself in a mirror he grunted disgustedly, 'That finishes it. The Mongols have the right idea, no more baths for me. What's the use? I'm going to bed.' The wind had begun again and developed into a full gale before the hour had passed."

THE RESULT OF TEN MONTHS OF DROUGHT

During the two weeks of our stay at Ula Usu there was almost continual wind, which made it extremely difficult to work and most uncomfortable merely to exist. The preceding ten rainless months had dried every scrap of vegetation and the Ula Usu basin showed hardly a trace of green. There was nothing to bind the sand and the wind whipped through our camp in unceasing yellow gusts. The camels arrived not long after we reached Ula Usu, and I sent them on to Ardyn Obo at once, as there was no grazing near camp. They were not in good shape, due to the lack of feed and the previous summer's hard work. Their humps were soft and flabby and many of them were decidedly weak.

THE FOSSILS OF THE SHARA MURUN BEDS

The abundance of titanothere bones at Ula Usu was amazing. There were many spots where hundreds of fragments lay in a white heap on the surface, the remains of skeletons which had weathered out and broken up. Although we discovered no complete usable skeletons, hardly a day passed that someone did not find a new skull or important bones. Remains of twenty-

seven titanotheres, including two genera and three species, were collected. All the Mongolian titanotheres have been described by Professor Osborn, who remarks: "Fortunately for purposes of correlation and bearing on zoögeographic relations in Upper Eocene and Lower Oligocene time, seven of the genera closely correspond in the two countries, namely, Mongolia and the Rocky Mountain region of North America."[1]

One titanothere skeleton, minus only the skull, lay in a cut bank, but the bones were so soft and chalk-like that it would have been exceedingly difficult to remove it; after being photographed and measured it was left in position. In addition to the titanotheres, two genera of Carnivora were discovered, and one of Artiodactyla. The latter Doctor Matthew identified as belonging to the family Hypertragulidæ and named *Archæomeryx optatus;* he says it "is of exceptional interest, as it appears to be an approximate ancestral type for the pecora. . . . So far as the higher ruminants are concerned, it affords tangible and very convincing proof of the theory of an Asiatic dispersal center."[2]

In 1925, Doctor Chaney found abundant remains of fossil wood in the Shara Murun formation. Although some of the stems appear to have been large, most of them are small and twisted, resembling those of trees and bushes growing in arid regions with a high range of temperature.

A TRIP TO JISU HONGUER

While the rest of us remained at Ula Usu, Morris and Young proceeded twenty miles to the west and camped at Jisu Honguer, where Permian strata had been discovered. They mapped the formation, which had been given the locality name, as well as recorded the rocks and collected fossils from them. This spot is exceedingly important, as it gave the first evidence of the great Mongolian geosyncline which had been so brilliantly predicted by Dr. A. W. Grabau.[3]

ULA USU TO ARDYN OBO

At the end of our stay at Ula Usu, we deposited more than a ton of fossils and a supply of gasoline at the temple Baron Sog-in-Sumu, to await our return. We then moved northwestward to Ardyn Obo, over the same trail which we had traveled during September, 1922. Everywhere the country showed signs of the unprecedented drought. There were very few Mongols, and, indeed, it was difficult to see how any living thing could find sustenance on the bare brown hills.

[1] Osborn, Henry Fairfield. 1925. "Upper Eocene and Lower Oligocene Titanotheres of Mongolia," *Amer. Mus. Novitates*, No. 202, p. 1; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 63, pp. 1–12, 1926.

[2] Matthew, W. D., and Granger, Walter. 1925. "New Mammals from the Shara Murun Eocene of Mongolia," *Amer. Mus. Novitates*, No. 196, pp. 10–11; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 59, pp. 1–11, 1926.

[3] Grabau, A. W. 1923–1924. "Stratigraphy of China," *Geological Survey of China*, Peking, Part I, p. 340, Pls. I, IV.

FOSSIL FAUNA AT ARDYN OBO

Ardyn Obo proved to be an important fossil locality, as our brief survey of the previous year had indicated. At that time excellent skulls of the aquatic *Cadurcotherium* and fragmentary remains of new genera of Artiodactyla, Perissodactyla, and Carnivora had been discovered. This visit yielded further additions to the fauna, in the shape of new genera and species in all the groups mentioned, as well as in the Rodentia and Amblypoda.

Perhaps the most interesting find was the remains of three titanotheres in a state of evolution distinctly advanced beyond those of Irdin Manha and Shara Murun. One, which Professor Osborn, 1925, has named *Brontops gobiensis*, has short, broad horns and a brachycephalic cranium. The specimen was discovered in the afternoon of the day before we had expected to leave for the Flaming Cliffs. I was anxious to get away and had announced that nothing but a titanothere skull would keep us longer. Therefore, when Olsen reported this fine specimen, just when the last packing had been done, all the staff were greatly amused.

THE OASIS OF GATUN BOLOGAI

Young and I had been off on a day's prospecting trip to the southwest, hoping to find a trail which would take us in the direction of the Flaming Cliffs at Shabarakh Usu, opposite the Gurbun Saikhan range of the eastern Altai Mountains, without taking the long route via Sair Usu and Tuqurik which we had done on our return the previous autumn. A Mongol, whom we saw not far from Ardyn Obo, said that he knew of such a trail, and volunteered to guide us across country to it. We had a rough trip over hills and up long valleys covered with sunburned sagebrush, and eventually arrived at a spring called Gatun Bologai. The spot was most entrancing, a veritable oasis in picturesque surroundings. In the bottom of a bowl-shaped hollow at the base of a range of jagged granite mountains lay a beautiful spring, which bubbled out from beneath a shrinelike monument. The waters ran down the gentle slope in a clear stream, reflecting the emerald green of the short, thick grass which bordered it for many yards on either side. Wagtails and Mongolian skylarks and beautiful sheldrakes were resting on the grass, while thousands of sandgrouse swept in to drink.

One can hardly realize how beautiful the oasis seemed to us after so many weeks without the sight of green grass! We hoped that we might bring the whole Expedition to see it with us, but unfortunately the guide's information went no further than the spring. True enough, a well-defined trail led up to it from the east, but there it seemed to end. We circled over the surrounding country in the car but could find no trace of a road leading to the west; neither were any Mongols visible in the sage-covered desert. The going for the car was

so bad that we could prospect only a small area, and reluctantly admitted that there seemed to be no feasible way out. Had we only known it, behind the barrier of granite peaks lay the very trail which would have taken us directly to our desired goal at the Flaming Cliffs! We returned upon that road in the autumn and were amazed to find ourselves so near the beautiful oasis. Moreover, less than two miles to the south there was a still larger trail, a main caravan route from Kweihwating to Uliassutai! But of these things we remained in ignorance until the end of the summer.

A VISIT TO OUR CARAVAN

Before making this reconnaissance we had visited our caravan where it was encamped thirty miles south of Ardyn Obo. We interviewed several Mongols who had lived in the region for years, asking them about trails to the west. They were entirely ignorant of both these caravan trails which we found later, although they were less than sixty miles away. Later we found natives, actually living beside the trail, who had not the slightest idea where it went!

Merin told me that it was necessary to rest and feed the camels, if they were not all to die within a few weeks. For many days they had been almost without food; only just enough vegetation could be found on the desert to keep them alive. The Mongols reported the country to the west to be in even worse condition than that through which we had passed. It was not an encouraging outlook for our caravan.

ON SHORT RATIONS

Nevertheless, it was imperative that the camels reach the Flaming Cliffs with gasoline and food for us; otherwise, we would be cut off from the most promising fossil deposits in all Mongolia. I made up loads for sixteen camels, consisting chiefly of gasoline, and just enough food to carry us along on short rations. These were to be put on the strongest camels and pushed through at all costs. The other camels with their loads were to be brought on as far as they could go; if they died their loads were to be left. Merin felt certain that, under those conditions, he could at least get the sixteen loads to us at the Flaming Cliffs.

We packed enough gasoline in the cars to take us to our destination, and food for a month. It was little enough, I felt sure, but even so the motors were greatly overloaded and could not carry another pound. Gasoline, food, and the Ardyn Obo fossils were left at the large temple near where the caravan was camped, to be picked up on our return. Thus we started on the long trip to the Flaming Cliffs via Sair Usu.

CHAPTER XIX

THE DISCOVERY OF DINOSAUR EGGS

WESTWARD FROM ARDYN OBO

We left Ardyn Obo on July 3, and encountered heavy going as soon as we ran out of the basin onto the sandy upland. One of the cars had to be unloaded and its contents carried up a long, soft slope; then we used it to help the others through the difficult places. Several hours of hard terrain gave us a rest, but in the afternoon two bad river washes confronted us. The sand was so soft in the second that it was impossible to drive the cars on the trail, which ran in the river-bed for more than a mile. The rough hills, which enclosed the channel, at first seemed impassable, but by careful driving we took the cars over them, and camped under a large elm tree; for the first time in months we were lulled to sleep by the sound of wind among the leaves.

THE FOURTH OF JULY, 1923

The next morning, it took two hours of strenuous work to progress three miles, but that took us onto fairly good going, and we proceeded without incident until three o'clock in the afternoon, when we camped eleven miles from Sair Usu. It was the Fourth of July, and I did not want to let the day pass without some sort of celebration. Moreover, we were near the spot where the geologists had discovered Palæozoic limestones; Morris wished to study the strata and collect its invertebrate fossils.

Our tents were pitched on a grassy shelf which projected like a verandah from the base of a rugged granite ridge. From it we viewed miles of brown basin; just below us was a fine well, and a few hundred yards beyond it a cluster of yurts. The afternoon was devoted to "cleaning up," pitching horseshoes, and such other games as we could devise. A "special dinner," with a number of delicacies which I had provided for birthdays and celebrations, made a very happy ending for the evening. The next day the palæontologists collected invertebrate fossils while Young and Johnson made repairs necessitated by an accident to one of our cars; on the 6th we pushed on again, the weather being clear and cool.

THE FIRST NEST OF DINOSAUR EGGS, DISCOVERED BY GEORGE OLSEN AT SHABARAKH USU IN 1923.

A leg bone of another one shown lying on the surface. The small sandstone ledge in the block was removed intact and sent to the Museum. In the center of the block of stone thirteen other eggs were discovered later.

A. PACKING FOSSILS AT SHABARAKH USU, 1923.

B. SKELETON OF *Oviraptor*, A SMALL SPECIES OF TOOTHLESS DINOSAUR.

This specimen was found lying directly above the first nest of dinosaur eggs discovered in 1923. Presumably it was an egg thief.

COMPULSORY MILITARY SERVICE IN MONGOLIA

We were following the Sair Usu trail, which led us over fairly good going, and camped at night near a temple called Menk Ta Urtu. Late in the afternoon we saw about two hundred Mongol recruits being drilled by Buriat officers, at a village of five or six yurts. As we neared them they formed in a double rank and stood stiffly at attention. A more ludicrous sight hardly can be imagined, for they had clothes of every description, and the huge boots with pointed upturned toes did not lend themselves to dignity when the wearer was on the ground. We were told that this was a concentration camp for men of the district who have been drafted into the army. They are given preliminary instructions at this first camp, and then taken to another where the recruits are more advanced. Later still they go to Urga to receive training under Russian officers. They remain in Urga for several months, and are required to return every year for a stated period of training. Lamas and "black Mongols" alike are taken, and we heard continual complaints from the natives throughout the country that there were not enough men left to look after the herds properly.

CAMP AT THE FLAMING CLIFFS OF SHABARAKH USU

We picked up a Mongol guide, who offered to show us a better way to the Flaming Cliffs than that by which we had come the previous September, but very soon we found the tracks of our motor cars, made ten months before. However, we had the benefit of previous experience, and reached Shabarakh Usu on July 8 at three-fifteen in the afternoon, with little real difficulty. We were delighted to be there. The country through which we had traveled was a parched, brown desert, and even the abundant sage near the Flaming Cliffs was burned dry and showed hardly a trace of green. Everything was exactly as we had left it on our last visit. The marks of our tents and the motor car tracks were almost as distinct as though they had just been made.

As soon as camp was pitched, the fossil-hunters wandered down the steep escarpment for a casual inspection of the new field. In less than an hour, Albert Johnson returned for his tool bag and reported the discovery of a large white skull. A few moments later Kaisen hurried up the slope for his collecting materials, and before we gathered for dinner that night every man had begun to excavate a dinosaur skull. Even I had had a share in the finds, for, while walking in the bottom of a ravine, I saw a pipe lying beside a rock. It was one that Granger had lost on our first visit, and strangely enough it had dropped within a few inches of the skull and jaws of a *Protoceratops*. Granger maintained that he had left the pipe to mark the spot, and that I had only rediscovered the skull, but I insisted upon having my name painted in red ink on the specimen after it had been bandaged and removed.

DINOSAUR EGGS

On July 13, George Olsen reported at tiffin that he had found some fossil eggs. Inasmuch as the deposit was obviously Cretaceous and too early for large birds, we did not take his story very seriously. We felt quite certain that his so-called eggs would prove to be sandstone concretions or some other geological phenomena. Nevertheless, we were all curious enough to go with him to inspect his find. We saw a small sandstone ledge, beside which were lying three eggs partly broken. The brown striated shell was so egglike that there could be no mistake. Granger finally said, "No dinosaur eggs ever have been found, but the reptiles probably did lay eggs. These must be dinosaur eggs. They can't be anything else."

The prospect was thrilling, but we would not let ourselves think of it too seriously, and continued to criticize the supposition from every possible standpoint. But finally we had to admit that "eggs are eggs," and that we could make them out to be nothing else. It was evident that dinosaurs did lay eggs and that we had discovered the first specimens known to science.

The eggs which had broken out of the sandstone block are eight inches long by seven inches in circumference. They are red-brown in color and are rather more elongate and flattened than those of modern reptiles; they differ greatly in shape from the eggs of any known birds, living or fossil. The outer surface of the shell is striated, with broken, longitudinal rugosities, but the inner surface is smooth; the shell is about one millimeter thick.

THE EGG-STEALING DINOSAUR

In the ledge beside which the eggs lay we could see many bits of shell embedded in the rock, and it was obvious that other specimens might be enclosed in the sandstone matrix. When Olsen brushed away the loose sediment on top of the ledge, he exposed the fragmentary skeleton of a small dinosaur. It proved to represent a toothless type, and Professor Osborn subsequently named it *Oviraptor philoceratops*. In referring to its habits he remarks:

"The generic and specific names of this animal, *Oviraptor*, signifying the 'egg-seizer,' *philoceratops*, signifying 'fondness for ceratopsian eggs,' may entirely mislead us as to its feeding habits and belie its character. The names are given because the type skull (Amer. Mus. 6517) was found lying directly over a nest of dinosaur eggs, the one photographed being actually separated from the eggs by only four inches of matrix. This immediately put the animal under suspicion of having been overtaken by a sandstorm in the very act of robbing the dinosaur egg nest."[1]

[1] Osborn, Henry Fairfield. 1924. "Three New Theropoda, Protoceratops Zone, Central Mongolia," *Amer. Mus. Novitates*, No. 144, p. 9; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 32, pp. 1–12, 1926.

The skull of *Oviraptor* is very peculiar, being a toothless derivative of an originally carnivorous type, with the stout jaws much shortened in front of the large eyes. It was a swift-running, bipedal animal, strangely birdlike, as was the American dinosaur *Struthiomimus*.

THE PRESERVATION OF DINOSAUR EGGS

All the loose bits of eggshell were most carefully collected, and a large part of the sandstone ledge was removed *en bloc* and sent to the American Museum. Subsequently, the block was found to contain thirteen eggs in two layers lying with the ends pointing toward the center exactly as they had been left by the dinosaur when she covered them with sand for the last time, millions of years ago. It is probable that the nest originally contained twenty or more eggs, and that they were deposited in at least three layers.

In considering the questions, why and how such delicate objects as eggs were so beautifully preserved, we may turn first to the geological structure of the deposit. Concerning it, Professors Berkey and Morris, 1927, write as follows:

"The rock is a red sandstone of very uniform grain and comparatively simple structure. The grains are exquisitely graded, so that when the stone is weathered, it yields a sand that will run like the sand in an hour glass. There is virtually no admixed clay, and separate beds of clay are few, occurring chiefly as channel fillings. . . . Cross-bedding, apparently of æolian type, is developed on a large scale at certain horizons. We believe that the formation is in large part wind-blown, and that this history is the major factor in accomplishing the perfect preservation of the delicate fossils which the Expedition recovered from it. The beds are very faintly disturbed, and show slight arches and saddles, but dip very gently toward the south."[1]

Moreover, there is evidence that during the formation of this deposit arid conditions prevailed. Our palæontologists found bits of fossilized wood in the beds. Doctor Chaney identified them as a desert type of tree.

Professor Victor Van Straelen of the Université Libre, Brussels, Belgium, who has studied the microstructure of the dinosaur eggshells, remarks:

"The eggs of *Protoceratops andrewsi* are of the utmost interest. From the rugosities of the outer surface together with the rare and extremely small pores, it is right to infer that the eggs had no outer cuticle. This is a character shown to-day by birds and turtles which lay their eggs in very dry regions. We may find herein a confirmation of the desert conditions prevailing in Mongolia during the formation of the Djadochta beds."[2]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, pp. 157–158.

[2] Van Straelen, Victor. 1925. "The Microstructure of the Dinosaurian Egg-Shells from the Cretaceous Beds of Mongolia," *Amer. Mus. Novitates*, No. 173, p. 3; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 49, pp. 1–4, 1926.

The dry country, the loose, fine sand and high winds explain how the eggs were so beautifully preserved. After they had been deposited in a shallow depression scooped out of the sand, the dinosaur doubtless covered them with a thin layer of sand, and left them to be hatched by the warmth of the sun. During a windstorm, such as occurs in the basin to-day, many feet of sand might have been deposited upon the eggs. Air and the sun's warmth were thus cut off, and incubation abruptly ceased. The weight of heaped-up sand eventually cracked the shells, and the liquid contents of the eggs ran out. Simultaneously the extremely fine sand sifted into the interiors, forming the cores of red sandstone which are present in all of our specimens, and prevented the eggs from being entirely crushed. One or two groups of small eggs which do not show crushing are filled with a fine-grained limy sediment, deposited from solution.

Since the eggs were thus gently buried in blown sand, and there is no evidence of water action, or of violent earth movements to disturb the deposit, they probably remained just as they were left, while the surrounding matrix became consolidated into rock. Two eggs of a group of three found on the surface were broken, exposing the delicate skeletons of embryonic dinosaurs. It is probable that other eggs contain the bones of unhatched young, for we found several skulls of baby dinosaurs, which evidently had been out of the egg only a few days before death.

A DINOSAUR NESTING PLACE

In 1923, and again in 1925, we found so many eggs and remains of so many hundreds of dinosaurs, that it was evident that this region was a concentration point for the reptiles, at least during the breeding season. Geological evidence favors the existence of lakes to the south, where the Gurbun Saikhan now stands. Streams doubtless ran into them, and at least one passed through the "egg beds." Therefore, food and water probably were abundant.

I believe, however, that this was not the primary reason for such a concentration of dinosaurs. It appears to me that a part of the answer, at least, lies in the peculiar quality of the sand. For successful incubation, the covering sediment must be loose and porous, in order to admit air and warmth to the eggs. It is quite conceivable that the sand in this spot was better adapted to act as an incubator than that in any other part of the country. I have often found sand-banks which were used exclusively by turtles as a depository for their eggs. Other neighboring areas, where the sand was either too coarse or too fine, did not contain a nest.

That this place had been a favorite breeding-ground for dinosaurs for a very long time, is shown by the fact that in 1925 eggs were found in different levels, all the way from the floor of the basin up to the very rim. There is a

PLATE LIV.

ANDREWS AND TSERIN AT HATT-IN-SUMU, 1928.

PLATE LV

A. BIGHORN SHEEP OF THE ALTAI MOUNTAINS AT ARTSA BOGDO.

B. HEAD OF *Ovis ammon*.

difference of two hundred feet between the highest and the lowest nests. Probably hundreds of thousands of years, to say the least, had elapsed between the time that the eggs in the lowest and highest strata were deposited.

A few days after the first discovery by Olsen, Granger found five eggs in a cluster. Albert Johnson also obtained a group of nine. Altogether, twenty-five eggs were collected during 1923. Some of them, as in the case of the original "clutch," were lying upon the surface, exposed by erosion that had worn away the sandstone in which they had been embedded; others were enclosed in the rock, with only the ends in sight. The eggs which Johnson found were considerably smaller and more elongate than those of the original set, and had smooth outer shells. Probably they were laid by a different genus or species of dinosaur.

A PARROT-BEAKED FOSSIL, *PROTOCERATOPS ANDREWSI*

The search for eggs was carried on coincidentally with the systematic prospecting of the entire basin exposures. As soon as a skull or other specimen was discovered it was removed, and then the rest of the area which had been allotted to each man was carefully inspected. Almost every day some one of the palæontologists reported the discovery of new and important specimens. By far the majority belonged to the species *Protoceratops andrewsi*, which had originally been discovered by Shackelford when he found the deposit in 1922. The type skull is about six inches in length and belongs to an immature individual. It was made the type of a new family, the Protoceratopsidæ, by Granger and Gregory, 1923, and served to show that we might expect to recover new forms of supreme importance from the Djadochta beds. About seventy skulls and twelve more or less complete skeletons represent this form. A series of *Protoceratops* skulls has been prepared, starting with an extremely young stage not long out of the egg and ending with a very old stage having a skull twenty-three inches in length. This superb series is unrivaled by that of any other species of dinosaur in any museum of the world; moreover, the fine sand in which the specimens were buried has preserved them so excellently that many are almost perfect.

When the original, incomplete skull of *Protoceratops* was described by Granger and Gregory, it was supposed that the type represented a direct ancestor of the ceratopsians, of which the giant horned *Triceratops* is the most spectacular example. Further study of our abundant and more perfect material has led Doctors Gregory and Mook, 1925, to modify their views as to its relationship to the other ceratopsians. I cannot do better than to quote Doctor Gregory's own words in regard to the significance of this interesting and important dinosaur. He says:

"In the second paper on *Protoceratops*, the present writer, in collaboration

with Dr. Mook, showed how *Protoceratops* completely realizes the implications of Dollo's inference that even the great horned dinosaurs were secondarily quadrupedal in posture, that is, that they had been derived from bipedal ancestors. For *Protoceratops*, while probably spending most of its time on all fours like the later ceratopsians, and while unmistakably foreshadowing the latter in many features, at the same time differs from them in retaining a series of peculiar characters in its skeleton which it has apparently inherited from bipedal ancestors that in many ways resembled *Psittacosaurus*. For example, its hind limbs are much longer and larger than its fore limbs, the hind foot being narrow and much longer than the fore foot, almost as it is in the bipedal *Psittacosaurus*, while in the more advanced quadrupedal ceratopsians of later times the hind foot was much broader and little, if any, longer than the fore foot.

"Again, the tibia or shin bone is longer than the femur or thigh bone as in running, beaked dinosaurs. The pelvis is more advanced than that of *Psittacosaurus* in the greater lengthening of the ilium, further reduction of the backwardly directed pubis, initial expansion of the prepubic process and slight downward curvature of the elongate rod-like ischia. These and other modifications of the pelvis indicate that *Protoceratops* at least spent more time supported on all four legs and less time running on its hind legs than did its less modified neighbor *Psittacosaurus*, while the enormous size of the head and jaws in proportion to the size of the backbone and thorax, as well as other marked specializations for the eating of herbivorous food, all give added reasons for the increased use of the quadrupedal posture and the gradual abandonment of bipedal running. Thus the *Protoceratops* was now getting big enough to stand and confront a hungry enemy, doubtless threatening him with his fierce beak, and no longer needed to turn and flee away on his hind legs.

"The skull of *Protoceratops* shows very pronounced modifications in the direction of the later ceratopsians. In the very earliest reptiles the whole surface of the skull behind the eyes was formed by a continuous shell of bone which covered over the jaw muscles. But by the time of the oldest dinosaurs this formerly continuous temporal region had become perforated by two prominent openings called the upper and lower temporal fossæ. Between these openings were left strengthened tracts or arches, an upper middle pair, the parietal crest, between the upper temporal openings, a second pair, the postorbital arches, above and behind the eyes, and a lower pair, the jugal arches, just above the lower jaw. In such relatively primitive beaked dinosaurs as *Psittacosaurus* the jaw muscles were of moderate size and the temporal arches did not extend much behind the joint between the upper and lower jaws. But in *Protoceratops* the jaws and jaw muscles had become very large and in so doing had pushed their supporting arches upward, backward and out-

ward, so that the skull is prolonged in the rear into a great spreading crest or frill. Formerly it was believed that this crest or frill, which is even further developed in the later ceratopsian dinosaurs, was evolved for the protection of the neck, but the construction of this region in *Protoceratops* plainly indicates that it functioned primarily as a scaffolding for greatly enlarged jaw muscles.

"Are we to conclude then that the horned dinosaurs (ceratopsians) acquired their special characters in Mongolia and then spread via Manchuria and the Behring Straits into Alaska and thence down to the Rocky Mountain regions? We cannot safely affirm this on the evidence afforded by any one type of animals, but we can affirm that there must have been some means of migration either in one direction or another. Some years ago Mr. Barnum Brown, of the American Museum of Natural History of New York, discovered the fragmentary skeleton of a small horned dinosaur in the Edmonton Cretaceous, Alberta, which he clearly saw was distinct from the larger horned dinosaur and to which he gave the name *Leptoceratops*. It is now evident that *Leptoceratops* is quite nearly related to *Protoceratops* and that it represents a little-changed descendant of the latter in North America at a time when the typical ceratopsians had reached the summit of their period of specialization. Some palæontologists will undoubtedly take this fact to mean that the larger ceratopsians were not descended from *Protoceratops* but from some undiscovered stem form. However this may turn out, it is safe to predict that even if *Protoceratops* be not the direct ancestor of the great horned dinosaurs, it was at least rather closely related to that ancestor and shows us a stage in which the ceratopsians had just acquired secondary quadrupedal habits and an enlarged bony scaffolding for the jaw muscles."[1]

The deep, parrot-like beak of *Protoceratops* may have been enclosed in a horny sheath. Gregory and Mook think that "the feet and tail of *Protoceratops* possibly indicate partly aquatic habits."[2] This may be true, but I doubt that the animal spent much time in the water.

SOME BIRDLIKE DINOSAURS OF CRETACEOUS AGE

Although *Protoceratops* remains far outnumber all others at Shabarakh Usu, it was by no means the only type of dinosaur that inhabited the region during Cretaceous time. I have mentioned the little *Oviraptor*, which was found on top of the original nest of dinosaur eggs, and Professor Osborn, 1924, has described two other theropods from the same beds, under the names *Velociraptor mongoliensis* and *Saurornithoides mongoliensis*. The former, repre-

[1] Gregory, William K. 1927. "Gaps in the Mongolian Life Record," *The Scientific Monthly*, Vol. XXIV, Part II, pp. 169–181.

[2] Gregory, William K., and Mook, Charles C. 1925. "On Protoceratops, A Primitive Ceratopsian Dinosaur from the Lower Cretaceous of Mongolia," *Amer. Mus. Novitates*, No. 156, Feb. 11, p. 2; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 40.

sented by a skull and jaws, one front claw and adjoining phalanges, seems to have been a small, alert, swift-moving, carnivorous dinosaur. The claw of the first finger of its hand was very large and short, like that of a falcon. The latter has a long rostrum and flattened teeth. The whole aspect of the *Saurornithoides* skull is so avian that we suspected that it might represent a new toothed bird. Professor Osborn, however, concludes that it "was a small cursorial theropod, more sluggish than *Velociraptor*, which was swift and raptorial in habit, but remotely related to it."[1] He thinks that it may possibly have been an egg-feeder, but remarks that such a conclusion must await the evidence afforded by the limbs. These dinosaurs are much too late in geological time to be ancestral to birds, but they do parallel them remarkably in their almost winglike hands and lightly built skulls. Remains of a larger dinosaur were also discovered at Shabarakh Usu; as yet these have not been identified.

A FOSSIL CROCODILE, *SHAMOSUCHUS*

Granger discovered the skull and jaws of a small crocodile which probably had been an inhabitant of the stream that ran through Shabarakh Usu. Dr. C. C. Mook, 1924, has named it *Shamosuchus djadochtœnsis*, remarking that it not only represents a new genus and species but possibly a new family as well.

HUNTING BIGHORN SHEEP AND IBEX ON ARTSA BOGDO

A short time after our arrival at Shabarakh Usu, McKenzie Young and I departed for Artsa Bogdo, sixty-five miles farther west, to hunt bighorn sheep and ibex. We needed specimens for both the American Museum and the Field Museum of Natural History. The work at Shabarakh Usu was entirely palæontological and geological, and was so efficiently handled by Walter Granger that I could be of no use there. I left word that a messenger was to be sent to us as soon as the caravan arrived. Young and I pitched our tents near a well at the base of the mountain several miles west of the previous year's camp. It was just below the high peaks where experience had taught me that we would find the buck ibex which, in the summer, left the lower mountains to the females and their young.

We drove down to the spring near the trail where there was a group of yurts, and were enthusiastically welcomed by the Mongols, all of whom we had seen on our former visit. They were unreservedly glad to see us, for it brought much of sport and interest and money into their dull lives. Very quickly we concluded arrangements for the hiring of ponies and the lama

[1] Osborn, Henry Fairfield. 1924. "Three New Theropoda, Protoceratops Zone, Central Mongolia," *Amer. Mus. Novitates*, No. 144, p. 7; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 32.

hunter who had proved himself to be such an excellent man. Then we went back to camp, feeling much cheered by our friendly reception.

The following days need not be detailed. They were a succession of delightful hunts amid picturesque mountains. Our method was to take a led pony carrying food, water and blankets, and climb to the summits of the highest mountains. We would spend the early morning and late afternoon hours hunting the peaks and ridges, and either rest or shift our ground during the heat of the day.

Hunting sheep and ibex at Artsa Bogdo is much less fatiguing than in most places, for it is possible to ride until one makes the final stalk. Having climbed to the summit of the mountain, we slept wherever night overtook us, and usually found game within a few hundred yards from where we had spent the night. Although we saw only a few really large heads of either sheep or ibex, we obtained a representative series of both species.

MONGOL PONIES

There is no water high up in the mountains, so it was necessary to carry enough in bags to last for twenty-four hours, at least. During that time the ponies would not be watered at all. They were tied up at night so that they could not graze, as the Mongols said that it would make them thirsty to eat the dry grass. About noon the next day we would descend to some stream or spring. Then the ponies would be allowed to drink their fill and graze for an hour or more. The Mongols have trained their ponies to go without water for twenty-four hours, and seldom let them drink oftener than that even when it is possible to do so.

Although I had had much experience with the Mongol ponies in Peking, and knew their qualities, the work which they did for us on those hunts made me realize that the half had not been told. No true Mongol pony reaches a height of more than fourteen hands, and those of the desert, where grazing was poor, were seldom up to thirteen hands. Yet, they carried us up and down mountain slopes so steep that it was all one could do even to walk; they were as sure-footed as goats, and at the end of a day of grueling climbing in the heat did not appear to be overtired. The Mongol pony probably represents a distinct type, although variations occur in different districts, largely dependent upon feed and other conditions. It is a general opinion that he is a direct descendant of Prjevalski's wild horse—the differences between them being due to the introduction of other blood. Certain ponies show an undoubted Arab strain, probably being a survival of the Arab horses brought to Mongolia during the time of Genghis Khan.

These ponies are never fed grain in Mongolia. They graze the year round, even in winter obtaining sufficient dry vegetation to keep them alive.

When they are brought to China they are given grain, of course, and adapt themselves to the change of climate, altitude, food and general living conditions in an amazingly short time. They make excellent polo and race ponies, and in the winter are used for cross-country hunting and steeplechasing. Their ability to carry a heavy man over a point-to-point course of eight or ten miles, with fifty or sixty jumps, compels the admiration of everyone who has seen them perform. The natives use them for racing, for every Mongol is a keen lover of sport. Their races are really endurance tests, for the course is anywhere from five to twenty miles. The ponies are ridden by boys about fourteen years old, who beat them from the start to the finish.

The terrible blizzards of the Mongolian winter take a yearly toll of about twenty per cent of the ponies but the stronger survive and increase the endurance of the breed. The herds seek shelter in ravines and press close together for warmth. The hair reaches a length of five or six inches, and then the ponies look almost like bears. The herds are often attacked by wolves; then the stallions gather the mares and colts close together, and galloping around them fight the wolves viciously with teeth and hoofs.

In certain individuals an admixture of horse blood is present, but this can easily be detected when one is familiar with the breed. The head is large, the forehand heavy proportionately to the quarters, the chest deep, and the neck and legs short. Judged by horse standards the Mongolian pony is not a beautiful animal, but "handsome is as handsome does." The Mongols make no attempt to improve the breed of the ponies, stallions running with the herd and serving the mares indiscriminately.

A SEARCH FOR OUR CARAVAN

While Young and I were at Artsa Bogdo, our minds were not entirely at rest, for the expected messenger announcing the arrival of the caravan did not come. We became so worried at last that I decided to leave the cook and camp-gear at Artsa Bogdo, put all the gasoline into one car, and drive back to Shabarakh Usu.

We reached there without incident on July 30, but were disappointed to learn that there was no word of the caravan. Matters were becoming serious, because there was only a very little gasoline left, and food and other supplies were running short. I immediately rationed our remaining food, and reserved all the gasoline for emergency use in a single car. Since the flour was almost gone, by unanimous vote it was kept only for pasting fossils. We were reduced to tea and meat. Fortunately there were many antelopes, and we purchased several sheep from the Mongols. We got along well enough, our only real hardship being the lack of sugar.

I also sent out our Mongols to the north and south on horseback to see if

they could get any word of our camels from the resident natives. They all returned without information. At last I selected two of our most trustworthy Mongols, Tserin and Bato, and instructed them to go back eastward on two different routes continuing until they found the caravan or arrived at the place from which it had started. The trails eventually converged, and Bato returned while Tserin continued eastward. He rode ponies until he reached a point where the feed was too scanty for horses, and then hired a camel. After riding six or seven days across an arid waste without seeing a human being, he encountered two lamas who attacked and robbed him. He was beaten insensible and was very nearly killed. Fortunately, the attack occurred only a short distance from a temple; he made his way there and remained for some time until he was able to start back to us. A month later he reached our camp in very bad condition, having ridden or walked more than three hundred miles. Almost anyone but a Mongol would have died. The poor fellow was heartbroken because, since he was so ill that he could hardly ride, he had returned without fulfilling his mission.

One day a wizened old lama priest rode into camp. Our Mongols greeted him with the greatest reverence and told us that he was a famous astrologer, who had heard of our predicament and had come more than thirty miles to help us. The Mongols said that he would be able to tell us exactly where the caravan was. The old fellow made elaborate preparations and, after a long incantation, announced that the caravan was many days' travel away from us, but that we would hear definite news of it in three days. He said that our camels were dying and that Merin was having a very difficult time. Our Mongols believed him implicitly. As a matter of fact, we did hear news of Merin in four days, because one of my men discovered him sixty-five miles to the west of us, at Artsa Bogdo, which was the destination that I had given him. He had found it impossible to cross the sun-parched desert and had circled far to the north, where there was better feed, leaving his camels at wells along the trail, or wherever they died or became so weak that they could no longer travel. Out of the seventy-five camels, sixteen came through, carrying food and gasoline and, above all, sugar! Eventually twenty-three more reached Artsa Bogdo. They had been left at a well in charge of two Mongols, and had been able to find sufficient food to give them strength to go on slowly. To celebrate the arrival of the caravan we had a big dinner with camel sage for table decorations, August 9.

THE GASHATO FORMATION AND ITS FAUNA

During the time that Young and I were at Artsa Bogdo, Morris had roamed the country on camel-back, studying geological problems. During his wanderings he discovered a new and exceedingly important formation in the

extreme eastern end of the Shabarakh Usu basin. This was an exposure of Paleocene age, the very earliest period of the Age of Mammals; it lies unconformably upon the Cretaceous deposits of the Djadochta formation which contain the dinosaur eggs and *Protoceratops*. The Djadochta evidently was subjected to a long period of erosion before these new Tertiary sediments were deposited upon it. About two hundred feet of gravel, and red and brown sandy clays, compose the formation, which was named Gashato.

Morris, Olsen and Buckshot spent some time searching for fossils in the exposure, but found bones in only two or three small pockets. Nevertheless, these few remains represent seven mammalian orders. In many respects it is a most puzzling fauna. In addition to two genera of the primitive multituberculates, there are parts of small upper and lower jaws about an inch long, bearing both molar and premolar teeth. These specimens Dr. W. D. Matthew and Walter Granger have named *Palæostylops iturus*. The genera have very definite affinities to the strange little hoofed mammals of Patagonia, called notoungulates. A tiny lower jaw from the Lower Eocene of Wyoming was the only previously known fossil of this type, except the South American specimens. Thus, Doctor Matthew remarked: "The minute and primitive notoungulate *Palæostylops* confirms the view that the South American Tertiary hoofed mammals were originally derived from the north, although undergoing a great secondary evolution in the Neotropical region."[1]

On the other hand, the fauna as a whole is somewhat surprising, as it does not represent the ancestral relations to the Eocene fauna of Europe and America that had been anticipated.

In 1925, a further collection was made from this formation, which included representatives of one new family, five new genera and six new species. Concerning it Doctor Matthew and his colleagues write: "Most of the mammals of the Gashato appear to represent phyla previously unknown. From the standpoint of European and American early Tertiary mammals they are aberrant, and, despite their early age and primitive stamp, they are for the most part too specialized and peculiar to cast much light either on phylogeny or on correlation."[2]

METHOD OF PACKING FOSSILS

Almost immediately upon arrival of the caravan, Olsen and Buckshot began to pack the great pile of fossils that had accumulated in the tents. The

[1] Matthew, W. D., and Granger, Walter. 1925. "Fauna and Correlation of the Gashato Formation of Mongolia," *Amer. Mus. Novitates*, No. 189, p. 2; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., I, No. 56, pp. 1–12, 1926.

[2] Matthew, W. D., Granger, Walter, and Simpson, George Gaylord. 1929. "Additions to the Fauna of the Gashato Formation of Mongolia," *Amer. Mus. Novitates*, No. 376, p. 2; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 93, pp. 1–12, 1930.

proper care of delicate specimens for their long journey across the desert was one of the greatest problems of the Expedition, for there is no wood of any kind in the Gobi and no other packing material than stiff grass. The food and gasoline cases provided boxes. Whenever the cars met the caravan we took food and gasoline from the wooden boxes and substituted fossils and other collections. The packing material was obtained from the animals themselves. The Mongolian camels grow very long wool to protect their bodies during the bitter cold of the winter, and, as the weather becomes warmer, this coat falls away in strips and patches. Whenever we wanted to pack a box, we simply pulled the necessary quantity of wool off our camels. No finer packing material could be devised, and a new crop continually appeared as the weather grew warmer and the camels shed more readily. But a certain amount of care had to be exercised in plucking the beasts; for a camel, in spite of his size, is a very delicate animal. If we removed his underclothes too suddenly he would very likely catch cold and whimper in the most disconsolate way, while great tears ran out of his eyes.

A HUGE HERD OF ANTELOPES NEAR GURBUN SAIKHAN MOUNTAINS

Just before we left camp at the red beds, Granger, Morris and I drove to the Gurbun Saikhan, "The Three Good Ones," an isolated range of the eastern Altai Mountains. It was August 10, and a day that I shall always remember because of the strange haze that hung over the desert. The year before, Berkey and Morris had explored the western end of the Gurbun Saikhan on camels, but had not gone to the north and east.

Well over toward the mountains we had an amazing spectacle of wild life—the largest herd of antelopes I had ever seen. The entire horizon appeared to be a moving line of yellow bodies and curving necks. As we ran toward them in the car, the great herd divided into groups of bucks, does and young. Thousands passed in front of us, sometimes stopping to gaze curiously at the car, or running just fast enough to keep at what they thought was a safe distance.

Nowhere else, except in Africa, would it be possible to see such a herd of wild animals. We estimated that at least six thousand were immediately in front of us, but there may have been twice that number, for the yellow groups stretched far beyond our sight. They were feeding upon rich grass along the lower slopes of the Gurbun Saikhan, where the mountains insured a greater rainfall. They belonged to the short-tailed species, *Procapra gutturosa*, which lives only on the grasslands.

ON LEAVING THE FLAMING CLIFFS

We were ready to leave the Flaming Cliffs on August 12. Even though we had been there for five weeks, specimens were still being discovered and

each one seemed finer than the last. Kaisen found a beautiful skeleton of *Protoceratops*, nearly complete, just before we left. It was lying on its belly, head out, with all four legs drawn up as if ready for a spring. Apparently the animal had not been moved since it dropped there in death millions of years ago. It was too fine a thing to leave, even though I was anxious to get away, and I told Kaisen we would wait while he took it out. But three others, which Olsen and Buckshot discovered, were left untouched. We had to stop somewhere, for apparently there was an inexhaustible supply of specimens in the wonderful basin. From that one locality our collection numbered sixty cases of fossils, weighing five tons. It included seventy skulls, fourteen skeletons and twenty-five of the first dinosaur eggs ever seen by human eyes. As Granger and I in departing gazed upon the glorious spires and battlements of the Flaming Cliffs, we felt that the desert had paid its debt.

CHAPTER XX

PROFESSOR OSBORN VISITS THE EXPEDITION

THE OSHIH BASIN

On August 12, the Expedition moved westward from Shabarakh Usu bound for the Oshih basin, the fossil-bearing locality opposite Artsa Bogdo, which Granger had discovered the previous August. Liu, one of the Chinese assistants, was left with a great pile of specimens to be brought up the next day. We looked forward to another harvest at Oshih, for during the few days Granger had spent there he had removed a beautiful and complete skeleton of a primitive dinosaur, *Psittacosaurus mongoliensis*, and had done but little prospecting.

From the trail opposite Artsa Bogdo, we made our way across country directly north to a narrow gateway through the rocks, and came down into a wide, almost flat lowland. A great red mesa, running east and west and capped with black lava, occupied the center of the basin. It was a most spectacular formation, and illustrated beautifully how the thick covering of lava had protected the mesa from the erosion which had worn down the surrounding sediments.

A PRE-MONGOL WALL

Across the western end of the mesa is a low wall of lava blocks, which extends for a mile or more well out into the lowland on either side. That the wall is very ancient was evident, but what its purpose could have been we were at a loss to know. Unless it had been extended right across the basin, thus blocking off the mesa and the entire western end, it could not have served as a means of defense. The Mongols could give us no information, merely saying that it had been "made by a people who lived a long time ago before the Mongols came."

BADLANDS

A dry stream-bed ran along the base of the mesa and made an excellent road for our cars. For five or six miles we went eastward, between the mesa

and the rocky hills to the south. Suddenly, without warning, we came to the brink of a vast complex of ravines, gullies and canyons, where the floor of the basin has been broken up by erosion into one of the most amazing and spectacular amphitheaters that I have ever seen. We pitched the tents on the very edge of the fantastic chasm. The wild chaos of sculptured walls and winding, jagged ravines suffused an atmosphere of unreality about our camp; it seemed that we were living in the world of yesterday, and that at any moment huge dinosaurs might wander to the doorways of our tents from out of the vast red canyons. Concerning the formation of this interesting region, the geologists, Berkey and Morris, 1927, have said:

"The depression known as Oshih is not a structural basin, but is essentially a desert hollow about eight miles wide from north to south, and at least fifteen miles long from east to west. The erosion features, therefore, are particularly impressive. The high colors of the strata and the badland dissection stand in striking contrast to the simple features of the surrounding rolling plains. A red mesa about three miles long, capped with black lava, stands in the middle of the hollow. It is a striking landmark. At the eastern end of the mesa one enters a great amphitheater-like depression, extending about three miles to the top of the hill Oshih Nuru, which forms the eastern end of the Oshih hollow. The sides of the amphitheater are fretted into a splendid badland area. From the north wall of the hollow, a great bluff about ten miles long, called Urulji Nuru, one can look northward over a perfectly simple, almost level topography representing the Gobi erosion plane; but in the depression everything is minutely dissected down almost to the very bottom. The myriad gullies, joining into fair-sized canyons which open into smooth floored valleys, indicate that the dominant erosive agent in the hollow is running water."[1]

THE "CANNON-BALL" SANDSTONE

The lowest member of the strata in the Oshih basin is a red sandstone, which contains a great number of spherical concretions. They vary in diameter from an inch or two to several feet, and cover the bottom of the basin as though it had been bombarded with stone cannon-balls. It was in this red layer that the *Psittacosaurus* skeleton was found.

FOSSIL FAUNA AT OSHIH

Although Granger's first work in the Oshih basin had given promise of a rich deposit, it soon became evident that our expectations were not to be fulfilled. By good fortune, he had found the only well-preserved specimen which

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, pp. 268–269.

PLATE LVI.

A. PROFESSOR OSPORN AND WALTER GRANGER AT IRDIN MANHA, 1923.

B. PROFESSOR OSBORN AND MCKENZIE YOUNG AT THE BARRIER, KALGAN, 1923.

A. PROFESSOR OSBORN, CHIEF ANDREWS, ASSISTANT CHIEF GRANGER.

September 16, 1923. Irdin Manha Horizon. Pit which yielded the first perfect titanothere skull, in the month of May, 1923.

B. MONGOL CAMEL RIDERS WITH LASSOES.

was exposed. Diligent search by all the members of the Expedition failed to produce anything like the adult *Psittacosaurus* skeleton and eventually we had to mark the Oshih basin as the single locality of the 1922 discoveries which had disappointed us.

A good deal of fragmentary material was collected. From this, two good skulls of baby *Psittacosaurus* were developed in the American Museum laboratory, as well as a fine adult skull and jaws in a large nodule.

Fragmentary specimens of other dinosaurs were also discovered. Two teeth, badly weathered limb bones, dorsal vertebræ, ribs and chevrons of a giant sauropod, which Professor Osborn, 1924, has named *Asiatosaurus mongoliensis*, gave the first indication of these huge dinosaurs in central Asia. He believes that it is related to *Camarasaurus*, but the material is too incomplete to make any precise comparison. The presence of a carnivorous dinosaur was also denoted by two teeth; this species has been designated as *Prodeinodon mongoliensis*. The skeleton of a small dinosaur, in a block of hematite, was discovered by Granger, but the matrix was so hard that the strongest tools were blunted. Since it would have been almost impossible to prepare it in any case, it was regretfully left *in situ*.

LIVING FAUNA AT OSHIH

Although we were disappointed in the palæontological results at the Oshih basin, nevertheless our stay of nine days was interesting. Twice we saw bighorn sheep on the hills, and one day, while sitting in camp, I saw a splendid ram standing on a pinnacle of rock projecting from the mesa; every night we heard the mournful howl of wolves and the sharp bark of foxes, deep down among the tortuous ravines.

Young, Vance Johnson and I ran back to the trail one day, and westward along it, looking for wild ass. We discovered several herds, and Young and Johnson each shot one specimen for our collection. As we were returning, about forty wild asses appeared from a valley between two small mountains. In close formation they swung past the car like a troop of cavalry, keeping perfect alignment until they disappeared over a low rise in the ground.

HUNTING TRIP TO ARTSA BOGDO

On August 21, we left the Oshih basin for a few days' shooting at Artsa Bogdo before turning homeward. A new cap of snow covered the summit of Baga Bogdo, and the air was already tinged with autumnal sharpness. Halfway to the trail we stopped to gather geodes, quantities of which were scattered among the lava blocks.

I had promised the men a real vacation when we reached Artsa Bogdo. We pitched camp high above the plain, at the very foot of the mountains, near

a well of excellent water. Ponies and hunters were hired from our friends in the Mongol village, and every man except Vance Johnson killed a sheep or an ibex during the allotted three days. On August 24, we broke camp hurriedly to avoid a torrential rainstorm which was gathering over the mountain summit. Rain caught us before we had driven the ten miles to the trail, where the caravan was camped. We got only the outer edge of the storm, but the roar of water on the slopes of Artsa Bogdo could be heard throughout the night.

OSHIH TO ULA USU

All our fossils and every item of unnecessary equipment were given to the caravan. Nevertheless, the cars were greatly overloaded with gasoline and food when we started eastward on August 25, at eight-thirty in the morning. An accident to one of the cars forced an early camp, near some pools of dirty rainwater in a dry river-bed. We named the spot "Clutch Collar Camp," because a similar breakage had occurred on the same spot the previous year. Next day one of the pinion gears broke on Number Five truck, when we were less than five miles beyond our night's stop. The day's run netted only sixty-five miles.

Our destination was Toylee-in-Sumu, where we had left the fossils obtained at Ardyn Obo as well as a supply of gasoline. How to get there was somewhat of a problem. Our hope was to discover a trail that led northward, but the few Mongols whom we saw maintained that none existed. On August 27 we made an attempt to run northward across country, but sand and extremely bad going drove us back to the trail. That night we camped in a wide, dry wash, which led into a narrow canyon through a low rocky ridge of granite. Half a dozen elm trees in the dry bed gave us a delightful surprise, and wood for camp-fires.

The next morning, while sitting at breakfast, I looked out of the tent door to see a herd of bighorn sheep feeding quietly at the upper end of the canyon. Vance Johnson immediately went out with his rifle and killed a young male. He was the only one of the party that had not shot a sheep or ibex at Artsa Bogdo. I was surprised to find sheep at such a low elevation, but we discovered subsequently that they inhabit isolated ridges far to the eastward. They make long journeys over the flat desert to reach high ground.

After driving forty-two miles eastward on a rough trail, we turned north across country to three Mongol yurts which were visible in the distance. The natives informed us that "not far away" was a good trail which led to Gatun Bologai, the beautiful spring and oasis which Young and I had discovered on the outward journey. If we could reach that place, we should know exactly where we were. A native from the yurts volunteered to guide us to the trail. His "not far" proved to be fifty-four miles, across some of the worst going for

heavily loaded cars that it had ever been my misfortune to encounter. Worn in body and spirit, we reached a broad trail eventually. Continued heavy sand forced us to camp at dark, just behind the granite ridge which backs the oasis on the west.

We reached Gatun Bologai next morning. Much to our disappointment, half a dozen caravans were encamped in the immediate vicinity, and the beautiful green lawn was a mass of sticky mud. Young and I had to endure the jokes of the rest of the party about the oasis of which we had drawn such alluring pictures. But the rest of the country was amazingly changed for the better, due to several rains which had tinged with green the parched desert vegetation. At Gatun Bologai we were in known country, and arrived at Toylee-in-Sumu by one-thirty of the same day. After taking aboard the gasoline, food and fossils which had been stored in the temple, we continued on to Ula Usu.

ARRANGEMENTS FOR PROFESSOR OSBORN TO VISIT THE EXPEDITION

According to plans made before we left New York in the spring, Professor and Mrs. Osborn were to arrive in Peking the first week in September. I decided to go in at once, with Young, to bring Professor Osborn up to the fossil fields at Irdin Manha. Vance Johnson and a Chinese chauffeur accompanied us with two trucks, to take the fossils stored at Baron Sog-in-Sumu to Erhlien. Granger was to remain at Ula Usu as long as he saw fit, but to move camp to Irdin Manha before September 15, when I expected to return with Professor Osborn.

We reached Erhlien (Iren Dabasu) on September 1, without incident except a broken axle, and Young and I started the same day for Kalgan. Johnson and the Chinese returned to Ula Usu with their two cars, after storing the fossils in the Erhlien telegraph office. Later the fossils were brought by car to Kalgan. Badly worn tires gave us considerable difficulty on the way, but we arrived at Kalgan on September 2, and I took the train the next day for Peking.

NEWS OF THE JAPANESE EARTHQUAKE

I never shall forget my shock, on being met at the station by Mrs. Andrews, Colonel Dunlap and Colonel Williams, to hear the news of the Japanese earthquake. Professor and Mrs. Osborn were aboard the S.S. President Madison, which was due to leave Yokohama on the day that the earthquake occurred. I had suggested that they take the train to Kobe instead of going by ship. If they had done so, it was quite possible that they had met death in the disaster. For three days, without success, we made every effort to learn what had become of the President Madison and other ships which were

known to have been in the harbor. The Japanese Government, fearful of attacks by other nations if the extent of the catastrophe became known, had instructed their war vessels to operate their wireless sets in such a way as to prevent radio communication. Such a mistaken conception of the sporting and humanitarian instincts of western nations caused much unnecessary delay in giving assistance to the sufferers, and untold worry to those who had friends or relations in Japan. Fortunately, the President Madison had left Yokohama and was sailing into the bay at Kobe when the earthquake occurred. Professor and Mrs. Osborn knew nothing about it until they were greeted in Shanghai by newspaper correspondents, and telegrams from the Secretary of State and myself.

PROFESSOR OSBORN'S FIRST VISIT TO MONGOLIA

On the ninth of September, Mrs. Andrews and I met Professor and Mrs. Osborn in Peking. I was so enthusiastic about the discovery of the dinosaur eggs and our other great finds, that, in spite of my resolutions, I could not even wait until we had reached home, but told the story to Mrs. Osborn before we had left the station platform. The Professor was so anxious to join the Expedition in Mongolia that we left for Kalgan two days later. The trip up the Pass was all that we had wished, and the night at Miao T'an gave Professor Osborn his introduction to a Chinese inn. We could hardly have had more beautiful weather, and the Professor's enjoyment, in being at last in the land of his prophetic vision, was immensely stimulating.

We reached Irdin Manha at four o'clock in the afternoon. Far in the distance, the blue tents showed in a beautiful mirage which waved and danced about in the sky, and settled to earth only as we drove into camp. After tea we walked to the fossil beds, where a titanothere jaw had been partly exposed for Professor Osborn's inspection, and then we visited the pit from which our first complete skull and jaws of a titanothere had been taken that spring. (Pl. LVII, fig. A.) It was within a few hundred yards of this same spot that Granger had discovered the first Asiatic titanotheres in 1922. We spent the next day at the fossil deposits of Iren Dabasu, which have gone into history as the first identified Cretaceous strata and dinosaur remains on the central Asian plateau.

THE SECOND CORYPHODONT TOOTH

Professor Osborn was exceedingly interested in a specimen which I had found at Irdin Manha. It was a single premolar tooth, representing an archaic group of mammals known as the Amblypoda. None of these great ungulates had hitherto been known in Eurasia, excepting *Coryphodon* of the Lower Eocene of France and England. This single upper premolar tooth was the only specimen of the group we had discovered in two years' search. Professor

Osborn considered it so important that he asked to be taken to the bench, about two miles from camp, and to have me photographed on the spot where I had picked up the tooth.

Later we drove ten miles down the valley and stopped for tiffin. As we were returning, Professor Osborn pointed to a low, sandy exposure a half mile away, and said:

"Have you prospected that knoll?"

"No," I said, "it is the only one in the basin that we have not examined. It seemed too small to bother about."

"I don't know why," said the Professor, "but I would like to have a look at it. Do you mind running over?"

When we stopped at the base of the hillock, I did not leave the car, but Professor Osborn and Granger walked out to examine the exposure. As he left, the Professor turned to me and said with a smile:

"I am going to find another coryphodont tooth."

Two minutes later he waved his arms and shouted, "I have it—another tooth!"

I could hardly believe my eyes and ears. Jumping out of the car, I ran to the spot. The tooth that I had found was the third or fourth upper premolar of the right side. The one Professor Osborn had discovered was the third or fourth upper premolar of the left side, and of almost exactly the same size. Naturally they could not have been from the same specimen, as the two had been found eight miles apart. These are the facts. The explanation of this remarkable telepathic coincidence is left to the psychologist.

WOLVES AND ANTELOPES

One afternoon at Irdin Manha we had an amazing experience with a wolf. Professor Osborn wished greatly to see for himself how fast an antelope could run. From camp, half a dozen gazelles, *Gazella subgutturosa hillieriana*, were visible on the smooth erosion plane. In the touring car, we raced them for a few miles and finally singled out a fine buck. He loped along at forty miles an hour, easily keeping in front of us, and would go no faster. I told the Professor that the only way to make him speed up was to drop a few bullets close beside him. As I stopped the car to shoot, a wolf suddenly dashed from behind the rim of a ravine and tried to catch the gazelle. Evidently it had been lying in wait, watching the buck, and when it saw that the gazelle would pass no closer, had made his dash. The wolf had almost reached the gazelle before the latter saw the danger; with a few bounds the gazelle leaped to a speed of sixty miles an hour, hopelessly outdistancing the pursuer. It was a remarkable demonstration of the method of attack by wolves upon antelope, and particularly surprising because of the conditions under which it was made. In spite of the

roaring motor car and half a dozen shots which had been fired, the wolf still made the attack. One would have supposed that the animal would have been so frightened that it would have slunk away, or remained concealed in the ravine, no matter how hungry it was.

MAKING CAMP IN FOURTEEN MINUTES

The last night before the Expedition returned to Kalgan we camped in a beautiful amphitheater among the grass-covered hills. I did not know until afterward that the Professor was timing the operation of making camp. It was exactly fourteen minutes from the time that the last car stopped in its place in the line until all the tents were up and the cook-fires burning. Every man knew his work so thoroughly that not a moment was wasted.

PLANS FOR THE FUTURE

Professor Osborn and I sat for a long time in front of his tent, discussing the future of the Mongolian explorations. We had opened a new country which had given undreamed-of revelations in the prehistory of the earth. It was obvious that the work could not be concluded satisfactorily in the five years originally allotted for the Expeditions. Eight years we estimated to be the minimum, and our decision was made before the Mongolian twilight had faded into darkness.

I felt strongly that the entire scientific staff ought to return to America to make a preliminary study of the collections and to obtain a new perspective on the work. Future explorations could be made much more intelligently if we knew what new facts our collections and data were bringing to light. Moreover, all of us had been so close to the work for three years that we felt the necessity of viewing it from a distance and through eyes other than our own. Of course, the increased time needed for the Expeditions meant almost double the original financial support. To obtain another quarter of a million dollars would be my chief business during the coming year.

COMMERCE ON THE HEELS OF SCIENTIFIC EXPLORATION

I immediately decided to sell all our motors in Kalgan. Vance Johnson was left to supervise this business, and in three days every car had been disposed of at amazingly good prices. Fur dealers and wool buyers had been watching our explorations with the keenest interest. Many had come to us at the end of the first year to inquire about routes for reaching the interior of Mongolia. We had told them how they could go and where to send gasoline for their prospective trips. Several cars had followed our advice with success. It was an evidence of how rapidly commerce follows on the heels of exploration. The dealers wanted our old cars, rather than new ones of the same make.

They had made the journey twice, and the Chinese felt that others might not be as good. As a result, we actually sold our cars for more than I had paid for them in America.

PLANS FOR A CHINESE NATIONAL MUSEUM

After returning to Peking, Professor Henry Fairfield Osborn had several conferences with the Premier, Minister of Foreign Affairs and other prominent Chinese who were interested in the plan to form a Chinese National Museum of Natural History. I had already done considerable work on the project, and a committee had been formed comprising most of the Cabinet officials. By Presidential mandate, a section of the superb buildings in the Forbidden City had been designated as a home for the Museum. The Central Asiatic Expeditions and the American Museum of Natural History offered to give duplicate specimens of all Mongolian collections. Also, a complete set of the American Museum publications was promised by Professor Osborn.

The project was making rapid progress toward a practical beginning, when one of the usual Chinese wars sent the Cabinet fleeing for safety to the Foreign Concessions at Tientsin, and nullified all our endeavors. Nevertheless, a large collection of Mongolian duplicates was deposited in the Museum of the Geological Survey, Peking, together with a complete set of American Museum publications.

END OF THE 1923 EXPEDITION

Merin had made a record return journey from Artsa Bogdo, bringing back all our collections and equipment in safety. We had the satisfaction of seeing them in Peking before I left for New York in mid-October with Professor and Mrs. Osborn. Mr. Granger remained to pack and ship the collections and to bring with him two of our Chinese assistants, Liu Hsi-ku and Kan Chuen-pao, "Buckshot." These men had done such excellent work in collecting fossils that we felt they were worthy of a year's education in the laboratories of the American Museum. I am glad to say that they fully justified our confidence. The remainder of the scientific staff had sailed for America before I left. The camels spent the winter and the following summer grazing on the plateau near our Mongol village, a hundred and twenty miles north of Kalgan.

CHAPTER XXI

PREPARATIONS FOR 1925

POPULAR INTEREST AND SUPPORT

I DID not realize what enormous popular interest had been aroused by our discovery of dinosaur eggs, until we arrived in Seattle. Newspaper representatives boarded the ship at Victoria, each one authorized to make a cash offer for the exclusive use of the egg photographs. Some of these reached thousands of dollars. I refused them all, however, as I could make no publicity arrangements until the Editor of *Asia* Magazine had made his selection of photographs with which to illustrate the popular articles I was under contract to write for them. Eventually the photographs were given to the press without charge.

The world-wide interest in the discovery of the dinosaur eggs assisted enormously in the financial campaign which I had to face during the winter of 1923–1924. Purely for the sake of publicity, we decided to sell a single egg to the highest bidder, the proceeds to go to the Expedition. This directed attention to the fact that we were urgently in need of funds with which to continue our work. Offers for the egg were received from England, France, Australia, New Zealand and many parts of the United States. It was finally purchased for five thousand dollars by the late Colonel Austin Colgate, and presented to Colgate University.

Although the sale of this egg aided enormously in stimulating public interest in the Expedition, nevertheless, I have wished many times since that the sale never had been made. It gave the impression to many Chinese, and to the Russian and Mongol authorities in Urga, that the fossil collections which we had gathered were of enormous commercial value. They naturally believed that all the eggs obtained were worth five thousand dollars. They never could be made to understand that that was a purely fictitious price, based upon carefully prepared publicity; that actually the eggs had no commercial value. As a matter of fact, we did try to sell another later and found no market at anything like five thousand dollars. Beautifully executed plaster casts of the eggs had been made and distributed *gratis* to the principal world museums, and their directors considered them quite good enough for exhibition purposes.

A winter of strenuous endeavor on my part resulted in the accumulation of two hundred and eighty-four thousand dollars for the Expedition. It came from almost every state in the Union, and conclusively demonstrated the wide public interest in our Mongolian work.

STUDY OF THE 1922–1923 COLLECTIONS

The scientific staff made excellent progress in studying the material gathered during 1922 and 1923. Professors Berkey and Morris were busily engaged upon Volume II, the "Geology of Mongolia," which was to be the first volume of the final publications of the Expedition. Mr. J. T. Nichols began the study of the superb fish collections which had been sent back by Mr. Pope. The reptiles collected by Mr. Pope had been accepted for determination by Mr. Karl Schmidt, of the Field Museum of Natural History, Chicago, by arrangement with President Stanley Field. The Field Museum had become a contributor to the Expedition and was to receive a duplicate set of all our collections, so far as possible.

Dr. Glover M. Allen, of the Museum of Comparative Zoölogy, Harvard University, agreed to identify and describe the ten thousand or more mammals which had been collected by the Asiatic Expeditions. In palæontology, Professor Osborn had taken up the study of certain groups; Doctors Matthew, Gregory and Granger were busy on others. New species, and such discoveries as it was deemed wise to put on record as soon as possible, were published in the American Museum *Novitates* or *Bulletin*. A steady stream of papers was thus issuing from the Expedition.

A NEW FLEET OF CARS

I made an arrangement with the Dodge Brothers Corporation for a fleet of new cars, especially designed for our purposes in the desert. The changes which we desired consisted of heavier springs, increased radiation, larger gas tanks and open "express" bodies. The cars which they produced were so satisfactory that we could suggest no improvements, even at the end of the Expedition.

WIDENING THE SCOPE OF EXPEDITION ACTIVITIES

When considering the 1925 Expedition we were unanimous in agreeing that certain additions should be made to the scientific staff. No factor was more important in determining the past and present animal and human life of the plateau than climate. Geological and palæontological data both indicated that there had been a succession of climatic cycles since Jurassic time, and possibly even before that remote period. Confirmation of this important induction could best be furnished by palæobotany. Moreover, a collection of the

recent vegetation on the plateau was of great importance, not only for itself but in connection with the zoölogical studies.

Dr. John C. Merriam, Director of the Carnegie Institution, came to our assistance by offering to detail Dr. Ralph W. Chaney to the Expedition for the 1925 season. We could not have had a happier choice. Although a palæobotantist by inclination, Doctor Chaney has a wide knowledge of geology, recent botany and zoölogy. His interest in all of these subjects greatly enhanced his value to the Expedition as a palæobotanist.

We also felt that the time had come for an archæologist to join our party. While all of us had done what we could in searching for evidences of primitive human occupation in the Gobi, the necessity for a trained man who could devote his whole time to this important science, was apparent. Mr. N. C. Nelson, who has had long experience in studying the primitive archæology of Europe, was our unanimous choice. Mr. Nelson discovered surface indications of early human occupation in Mongolia from almost our first camp throughout the entire traverse. We had covered much of this same region in our previous expeditions without making any archæological discoveries, so that Nelson's work demonstrated how essential was a trained investigator.

An expert topographer we all felt to be essential. Professor Morris had done this work on our first two expeditions, but this together with geology was too great a task for one man. Doctor Berkey suggested his friend, Major L. B. Roberts, U. S. Army Reserve, to handle the topography, and his appointment was strongly urged by the Chief Engineer of the United States Army. Major Roberts was responsible for the development of new methods of rapid mapping and needed all his ingenuity to keep pace with the Expedition. For his assistants, I selected Lieut. F. B. Butler, U. S. A., and Lieut. H. O. Robinson, First Royal Lancashire Regiment (British): young officers who also rendered much assistance in ways other than mapping.

Doctor Berkey arranged to rejoin the Expedition for the 1925 season, as did Mr. Shackelford. We obtained the services of Mr. Norman Lovell (British) as Assistant Motor Transport Officer and of Dr. Harold Loucks of the Peking Union Medical College as Surgeon. The Expedition, as thus reorganized, included a foreign staff of fourteen men, and the sciences of palæontology, geology, palæobotany, archæology, zoölogy, topography and photography. In addition, Mr. Pope continued his work on herpetology and ichthyology in China.

A TRIP TO URGA TO OBTAIN GOVERNMENT PERMITS

By the middle of June, 1924, I had completed all necessary arrangements, and sailed for China, reaching Peking on July 4.

The 1925 Expedition was to explore a new route to Tsagan Nor and then

PLATE LVIII.

NORMAN LOVELL REPAIRING A MOTOR CAR, 1925.

PLATE LIX.

A COMMERCIAL TRANSPORT CAR RUNNING BETWEEN URGA AND KALGAN.
This five-passenger Dodge motor car carried a load of 1,400 pounds, 1925.

continue westward along the northern slope of the Altai Mountains into untouched country. In order that we should not be subjected to delays in obtaining permits from the Mongolian Government, I decided to go to Urga to make the necessary arrangements in advance.

I left Peking at the end of August, accompanied by Norman Lovell, F. A. Larsen and Gordon Verecker, Esquire, First Secretary of H. B. M. Legation, Peking. Mr. Verecker's object was merely a pleasure trip to Urga.

A SUMMER OF UNUSUAL RAIN AND FLOODS, 1924

It was a summer of unprecedented rains, and in August Kalgan was partly destroyed by a flood. Hundreds of thousands of tons of loess were brought down by the river which flows through the center of the city. The bridge was carried away and all the business sections flooded. Shop doors were literally sealed with mud. The Chinese take such calamities philosophically, and they slowly dig themselves out, leaving ridges in the center of the streets, to be worn down by traffic as time goes on. A week of intelligent work would have cleared the entire business section, but no one thought of doing it after his own particular doorway had been opened. It was with the greatest difficulty that we forded the river at Kalgan with our car.

The rain had also reduced the Wan Ch'uan Pass to a chaos of rocks and ruts. Only a motor of the strongest construction could have negotiated the Pass. The trip across Mongolia to Urga was pleasant and uneventful. The unusual rain had induced a wonderful growth in the grasslands, and even the Gobi was so clothed with green sagebrush that it hardly resembled the normal grim desert.

NEGOTIATIONS IN URGA

We were required to submit to the search of our persons and effects by the insolent Buriat officials in Urga and to the still more annoying investigation by the Soviet Secret Police, even though I had notified the Government authorities by telegraph of our arrival and we really were coming at their invitation.

Fortunately, our friend, Mr. T. A. Badmajapoff, was in Urga and he undertook to conduct negotiations on our behalf with the Premier and Ministers of Education and Foreign Affairs. It was a delicate business and, of course, was carried on without regard for time. A few weeks or months meant nothing in their lives, and the fact that I could not remain in Urga all winter, awaiting their pleasure, was simply my misfortune. I found that a Scientific Committee had been formed, apparently for our benefit. Its object appeared to be to obstruct our scientific work as much as possible, for its members had conceived the idea that the fossils we were taking out of the country were worth hundreds of thousands of dollars. Then the Secret Service took a hand and said that we

could not be allowed to make maps or do any topographic work whatsoever. It was a pretty difficult situation, but, guided by the astute diplomat, Badmajapoff, I made considerable progress. At the end of three weeks the authorities had agreed to permit the Expedition to work in Outer Mongolia under certain conditions. These included the presentation to Urga of a duplicate set of all our collections, publications and maps. To house the material they would build a Museum. Moreover, we must take with us two Mongolian representatives, one from the Scientific Committee and the other from the Secret Police. These gentlemen were to act as the recording angels of our actions. I was to pay their expenses and salaries as well. The passports for ourselves, cars, camels and equipment cost three thousand dollars. It was agreed that they would be sent to me in Peking, for at least a month would be required for their preparation. It was exasperating beyond words, after all our previous work, to meet the same suspicions as in former years. The Buriat "advisers" pointed out that it was not reasonable to think that we would come from America, have a great caravan of camels and a fleet of motor cars, bring forty men and spend hundreds of thousands of dollars, just to dig up a few old bones. That was too ridiculous for any intelligent man to believe. Of course, we had an ulterior motive. Perhaps it was to search for oil or minerals; possibly we were spies; but certainly there was some dark reason for our presence in Mongolia. It was exactly the same type of argument that we met in 1922. Fortunately, our previous record in the country was so good that even these new officials, who had been in Urga only a short time, were at last convinced that the Expedition would not be a serious menace to the safety of the State.

GENERAL KOZLOFF, A RUSSIAN OF THE OLD SCHOOL

One delightful incident of the Urga visit was the opportunity to meet General P. K. Kozloff. For years I had admired this famous Russian explorer who had been a companion of the great Prjevalski. I had had several letters from Kozloff and felt an intense desire to know him personally. He had made preparations for a two-year expedition into the southern Gobi in the region of Kara Khoto, under the auspices of the Leningrad Academy of Sciences. The day before he was to leave Urga for the desert, a telegram was received from Moscow directing the authorities to prevent him from starting. General Kozloff was completely at a loss to understand the reason for his detention and was unable to get any information concerning the situation. He had been a general under the Czar but had devoted his life to exploration and taken no part in politics.

Kozloff, although nearly sixty-five years old, is a man of such energy that he could not long remain inactive. Being an enthusiastic ornithologist he began to make a collection of birds of the Urga region. One of his trips took

him into the forest some sixty miles north of Urga, on the Kiachta road. He discovered a series of large mounds, overgrown with trees and underbrush, but of such a regular character that he suspected they could not be natural. After obtaining permission from the Urga authorities to investigate he sunk a shaft in the center of one of the largest mounds. About fifteen feet underground he found a rectangular chamber containing a coffin and other objects. These were subsequently identified as belonging to the T'ang Dynasty. A number of tombs were opened and the materials sent to Russia for study. It developed into such an important investigation that Kozloff postponed his proposed trip to the southern Gobi until 1926.

While I was in Urga he invited me to accompany him to the excavations and inspect his work. I went down the shaft into one of the larger tombs and spent a most interesting day examining the materials and surroundings. Kozloff's enthusiasm at sixty-five was as great as though he had been a boy of twenty. I count it as an exceptional privilege to have had the opportunity to meet this great explorer of the old school and to see him in action.

ACKNOWLEDGMENT TO T. A. BADMAJAPOFF

Before I left Urga the Premier assured me that our various permits for the next summer's work would be issued in due course. Without the aid of Mr. T. A. Badmajapoff we should never have been able to overcome the suspicions and to reach an understanding with the Urga authorities. We owe him a debt of gratitude not only for this splendid work on our behalf but also for his previous assistance to the Expeditions. He worked for us in the most unselfish way and, being so thoroughly respected by all factions in the Government, his championship of our cause was most valuable. He had been a member of one of Kozloff's earlier expeditions, as well as having accompanied us in 1922, and has a keen interest in exploration and scientific research.

SUPPLIES AND EQUIPMENT FOR 1925

Some weeks after returning to Peking, our passports, motor car and camel permits arrived in the care of Mr. F. A. Larsen. I devoted myself during the winter to the preparations for the coming Expedition. Four thousand gallons of gasoline and one hundred gallons of motor oil were especially packed by the Standard Oil Company at the Tientsin office under Mr. Lovell's supervision. Two and one half tons of flour, a ton of rice, half a ton of sugar and other supplies made a mountainous heap on the laboratory floor. Lovell and I packed all the food and equipment and took it to Kalgan by train.

I ordered Merin to bring in the camels, and on February 20, 1925, the caravan left for its long trip into the Gobi. I gave Merin instructions to go straight to Shabarakh Usu and await us there. He was to proceed by slow

marches, resting the camels wherever he found good feed, but must arrive at the Flaming Cliffs before May 1. Our base would thus be well-advanced for the long westward exploration, and the camels fresh. While we were working at Shabarakh Usu, the caravan would push on rapidly along the northern base of the Altai Mountains. Armed with a sheaf of Urga permits for the camels, we anticipated no trouble for Merin in crossing the frontier into Outer Mongolia. After the caravan left, Lovell and I occupied ourselves in preparing the outfit for each of the men, inspecting and sorting the motor equipment and getting everything in readiness for immediate departure after the staff arrived. By April 7, we were all assembled in Peking and ready to leave for the desert.

CHAPTER XXII

START AND TOPOGRAPHIC WORK

THE NEED FOR A MORE ACCURATE MAP

NEARLY all the existing maps of Mongolia are based on the Russian map, which is very unreliable. Apparently much of it was prepared from native information, and this is proverbially bad. Mountains appear where there are no mountains. Many of the largest caravan trails are omitted, and important natural features are located incorrectly. In consultation with Major L. B. Roberts, we determined to make our survey more accurate than any other that had been attempted previously on the central Asian plateau. Instead of relying upon aneroid barometers for altitude, Major Roberts decided to carry his line of levels from the Kalgan railroad station, with a plane-table and Gurley telescopic alidade. Barometers were not used on the main route survey at any time during the season.

It was by no means easy to carry out the initial and most important stage of the survey. Marshal Feng Yu-hsiang, who then was in charge of the Kalgan region, had refused to permit another foreign geological party to make a survey of the Pass. There was no probability that we would fare better at his hands. In such cases, in China, I have found that the best plan is to go ahead until you are stopped. It is quite possible to make unending trouble for oneself by being too conscientious in the observance of rules. Therefore, I instructed Major Roberts to say nothing to the authorities, but to do his job. If he got into trouble, I would guarantee to get him out of it.

Major Roberts left Peking for Kalgan with Lieutenants Butler and Robinson on April 11, 1925. On the 13th, very early in the morning, they repaired to the railroad station, set up the plane-table and stadia rods, and began the survey. The few soldiers posted at the station were too lazy and ignorant to do more than glance at their operations, and did not report them to their officers. By the end of the day Roberts had carried his levels ten miles or more beyond the station and returned to Kalgan to sleep. The next day, with their camp gear piled in a cart which proceeded by road, the topographers reached

Wan Ch'uan, and by April 16 had completed the line to the village of Miao T'an, on the plateau, where they were to await our arrival. They had not been molested by the soldiers, and had carried out their work according to schedule. The summit of the Pass was determined as 5007 feet above sea-level.

SICKNESS OF ONE OF OUR STAFF AT KALGAN

On April 15 the rest of the staff left Peking for Kalgan, with the exception of Shackelford and myself. Shackelford wished to make further tests with the radio set, upon which we were depending for time signals to check our chronometers. We went to Kalgan on April 16 and met Young, who had been up to Chap Ser to bring down our three Mongols. He reported the Pass to be in such bad condition, due to recent rain, that I decided to wait a day for the road to dry. That evening Doctor Berkey developed a temperature of 104°, and Dr. Loucks was greatly worried. He feared pneumonia. Rather than wait for Berkey's recovery in Kalgan, where the staff would be idle, I decided to go on as far as Ula Usu and send back for Loucks and Berkey. At Ula Usu everyone could be occupied with effective work. Berkey was better next morning, April 18, and Dr. Loucks had hopes that he would be able to travel by the end of the week. Knowing Berkey's indomitable will and his remarkable constitution, I felt sure that he would be out of bed before then.

START OF THE MAIN PARTY

At nine o'clock in the morning April 18, 1925, we left Kalgan, and found that the road had dried considerably. Moreover, Marshal Feng Yu-hsiang was planning to send out five or six motor cars to attack bandits who had been raiding on the plateau. In preparation, he had several hundred soldiers working on the road, rolling out the rocks and filling in the deep cart ruts.

When our cars started for the Pass they made a very impressive spectacle. The huge trucks, flying American flags, and piled high with baggage and men, looked like battleships under full steam. It would take a pretty strong band of brigands to worry us. Between the summit of the Pass and Miao T'an the going was so bad, due to recent rains, that one or another of the cars was mired every few miles. At about five o'clock a duststorm began and continued with such violence that we were only just able to reach the Chinese inn at Changpeh-hsien. During the last two miles we were almost blinded by the dust, and had to grope our way to the village.

ACTIVITIES OF BANDITS

As usual, bandits had been active along the hundred miles of road from Kalgan northward to the end of Chinese cultivation. Several great caravan trails converge toward Kalgan, and the villages offer protection to the robbers.

A week before we left, three American cars, loaded with eighty thousand dollars' worth of sable skins, had been robbed within fifty miles of Kalgan. Other automobiles had met a similar fate, almost every week. Before we started, the Foreign Commissioner at Kalgan had demanded that I sign a statement releasing the Chinese authorities from all responsibility for our personal safety. Otherwise, we would not be allowed to proceed. Although it was a bad precedent to establish, I felt quite certain that we were much too strong a party for brigands to attack. As long as Chinese bandits can rob defenseless caravans they maintain a bold front, but they dislike exceedingly to be shot at themselves. Foreigners, as a rule, shoot much too well, and they do not follow the Chinese custom of running at the first sign of danger. Twenty Chinese soldiers, be they bandits or otherwise, to one foreigner, is about the proper ratio for anything like a good fight.

CHANGPEH TO WOLF CREEK

The next morning, Sunday, April 19, we were checked at the river five miles beyond Changpeh. The bridge had been carried away and while the water was then only three feet deep, the bank on both sides had been cut by carts into a mass of gluelike mud. Hundreds of camels, carts and ponies, besides two hopelessly mired cars, were waiting at the river. It seemed impossible to cross, but, by careful wading at the ford and testing every foot of the bottom, we managed to find a passable route. A huge Chinese car loaded with ammunition was half sunk in the center of the stream. The soldiers were in despair, but we rigged a block and tackle and had it out for them in a half an hour.

Proceeding to Miao T'an, we repacked the cars and sent the topographers forward to carry their line up the road. In the meantime I took several of the men out to shoot geese, which were feeding in thousands on the green blades of wheat in the fields. The next morning, shortly after leaving Miao T'an, a Russian car reported fifteen bandits ahead, but they disappeared before we arrived. Roberts and his men carried their line forward with amazing speed, because while we were in the cultivated area they had houses and other objects for fixed "shooting" points. Later, on the plains, topographical work became more difficult and other methods were developed.

We stopped for the night five miles south of Chap Ser, in the bend of a little stream which the Mongols called "Wolf Creek." Dry, yellow grass made a clean floor, and, in spite of the fact that it was our first camp, the tents were up in less than half an hour. After dinner we all gathered in the mess tent about an argul fire, for the temperature dropped to +20° F.

The next morning, when we were all packed to leave, I discovered that my car would not start. Investigation disclosed a broken timing gear. The Dodge

Brothers engineers had been so certain that this could not possibly happen, that we had not included any of the gears in our assortment of spare parts. There was nothing for it but to remain where we were while Young returned to Peking for a new gear. At the same time he could bring back Berkey and Loucks. While our camp was an excellent one in most respects, I was somewhat worried because it was in the center of the bandit region. Most of the robberies had taken place within a few miles of Wolf Creek. Nevertheless, we had no choice but to remain.

EXPEDITION ACTIVITIES AT WOLF CREEK

Young left Wolf Creek for Kalgan at 10:30 A. M. April 21, and I drove up the road to the topographers, who had gone ahead of the main party. I instructed them to proceed as far as our Mongol village, 120 miles from Kalgan, where we were to leave the main road. Then they were to return to camp. The next day some of the men went off to a considerable lake, six or seven miles to the east, to shoot ducks and geese. Nelson prospected the surrounding region for artifacts but found nothing of interest. Morris was busy on geological problems. Early the next morning Shackelford and Butler received a message over the wireless from Young, which read, "Berkey well but weak. Leaving Kalgan Saturday, April 25." It was a bad start for the season, but I have found that a bad beginning often is followed by a good ending.

The topographers kept themselves busy in making a detailed map, on the scale of 1 to 20,000, of the Hallong Ossu region where we were camped, showing the typical grassland topography. It extended as far as the Swedish Mongol Mission station in charge of Rev. Joel Eriksson. I knew the Mission people well, and later Mr. Eriksson became the Expedition's agent in Mongolia. He had had considerable training in medicine and surgery, although not a graduate doctor, and his medical work was a great boon to the Mongols of the district.

Mr. Eriksson took Granger and Morris over to the fossil beds at Ertemte, which Doctor J. G. Andersson[1] had discovered in 1919–1920. They did not attempt to do any work there, as we had not yet been informed that Doctor Andersson had abandoned his investigations. For a few days the weather was beautiful, with warm, bright sun, little wind, and clear, cold nights. Toward the end of the week, gales began, which made the topographic work difficult and uncomfortable. Major Roberts and his men kept at it, in spite of the weather, and by April 26 had completed the area map. As we also obtained a splendid collection of the mammals of the region, the time was by no means lost.

[1] Andersson, J. G. 1923. "Essays on the Cenozoic of Northern China," *Mem. Geol. Survey of China*, Series A, No. 3, p. 46.

PLATE LX.

CROSSING THE ONGIN RIVER.

Canvas hoods are placed over the front of the cars.

A. [illegible] AT [illegible] OBSERVING [illegible] ALTITUDES OF THE SUN.
Shabarakh Usu, 1925.

B. THE EXPEDITION STAFF AT LUNCHEON, SHABARAKH USU, 1925.

INCREASED ACREAGE UNDER CULTIVATION

It was interesting to see how Chinese cultivation was being pushed northward toward the edge of the desert. Every two or three years the Chinese open a new tract for settlement and, as soon as this is occupied by farmers, the border line of cultivation is advanced still farther. In the last seven years it has gone northward forty miles. The Mongols who occupy the frontier region are simply forced to retreat as the Chinese progress. The advance of cultivation is dependent, to a large extent, upon war and bandits. When political conditions are disturbed the rate of settlement is slowed down. It is much like the former frontier days in America, except that the Chinese farmers make no effort to defend themselves against the bandits.

MUNITIONS FOR MARSHAL FENG YU-HSIANG

We discovered very soon why Marshal Feng Yu-hsiang, the so-called "Christian General," had objected to our going out to Mongolia. He knew that a clash with Chang Tso-lin was inevitable in the not far distant future, and was preparing himself with arms and ammunition from Russia. Great quantities passed our camp daily in motor cars, and fifteen hundred camels were reported to be south of P'ang Kiang. Since Feng had categorically denied his Russian affiliations, he was not anxious to have foreigners on the road who would tell the truth.

AT TSERINVILLE

Although our camp at Wolf Creek was fortunately located so that most of the men could find something to do, we were delighted to be able to leave when Young arrived on Sunday, April 26, with Doctors Berkey and Loucks. They had encountered such a terrific sandstorm, at the top of the Pass, that they could not travel the previous day. Berkey was still weak, but had made a remarkable recovery under Doctor Loucks' careful nursing.

We left at 7:30 the following morning, April 27, and turned off the road to the west at our village twenty miles from Chap Ser, which we named "Tserinville" after Tserin, one of our Mongols. Running through beautiful rolling grasslands toward the Sair Usu trail, we made good progress until the afternoon.

METHOD OF TOPOGRAPHIC SURVEYING

Then the topographers found that the country had become so flat that they could no longer use natural objects for sights with the alidade. Major Roberts immediately put into practice a method which he had devised for such an emergency. In Peking, when discussing his plan of carrying line and levels from the Kalgan railroad station, he had met with the usual derision. He was

told that in a flat country, where prominent natural objects were almost non-existent, it would be impossible to make a rapid survey. He met this difficulty by using the motor cars as stadia rods. The height of the hub, fender and windshield were known, and these points were sufficient, since the length of sight was from one to two miles. The distance was taken by speedometer, which had been carefully rated. The scale of the route maps was 1: 200,000 and the contour interval was 50 feet.

Two other cars were detailed to assist the topographers and to act as foresight and backsight stations. While the backsight was being taken on one of these cars, the other would run on and pick up a point for foresight. The backsight having been completed, the rear car would be signaled, run forward, and while the foresight was being taken, pass the topographers and be ready in turn to establish another foresight. The average day's run with this system was fifty-eight miles and the maximum seventy-three and a half miles. The levels were carried by the table itself, and in many of the set-ups the topographers had level readings. Usually it was possible to step the vertical difference with the stadia hairs, and only rarely was recourse had to the Beaman arc.

The speedometer on the topographers' car was frequently checked against courses from fifteen to twenty miles long, which had been laid out by stadia. The use of the speedometer in measuring distance was more or less of an experiment, but the manner in which the traverse closed in on the control points fully justified the confidence in its use. Naturally, since the differences in elevation were frequently a function of the distance run, the question of the accuracy and suitability of the speedometer distance was one of double importance. In certain instances where the nature of the ground was such as to cause an excessive error to arise from the use of the speedometer, the strip would be crossed by using the stadia. Sights as long as twenty-five miles were used in locating mountains and other features adjacent to the line.

To one who has not worked with this or similar methods, the value of such a reconnaissance may seem questionable. The results of the season's work proved the system sound, however, and possible of wide development. In addition to the check afforded by closure on control points, there were opportunities to intersect on distant, prominent mountain peaks, from various points. The invariable small triangle of error was a constant check on distance and orientation of the base-line. In addition to barometer comparisons, a check on line-levels was afforded by vertical angles read to these peaks from various stations along the route, when possible. Several times each day magnetic north was plotted on the route-field sheet, the solar chart being used to establish the meridian. Establishing meridian in such a way was sufficiently accurate to be commensurate with the compass needle used. When the agonic line of the Eastern Hemisphere was crossed, much local attraction was detected and

many reversals recorded, all of which made the topographers appreciate the solar chart as their most valuable aid.

Whenever we were in camp for a day, latitude and longitude were determined. Latitude was fixed by observation of Polaris off the meridian, the hour angle computed and correction applied. For time and longitude the equal-altitude method was used, both sun and stars being observed. This work was in Lieutenant Butler's hands.

We carried with us three Hamilton chronometers; one was a No. 950 (watch movement) and two were torpedo-boat type clocks. We had expected to check our clocks with time signals by radio, but when we reached Outer Mongolia the authorities would not allow us to use the radio set. Therefore, time, upon which the locations ultimately depended, was a weak factor. Traveling in motor cars and covering such a great distance in a day, the chronometers were subjected to frightful conditions. To offset this, certain stations were occupied for long periods at a time and the rating of the clocks could be determined over these periods.

Likewise, on the run-back many of the original stations could be reoccupied after even a longer period of time, so that excellent field ratings were obtained. From the last of such observations to the final check-in and rating upon the return to Peking, a minimum of time elapsed, so that the over-all and intermediate rate has been established accurately. The error, as computed from the rates determined in the field, coincided in a gratifying manner with the compared error as found by radio check in Peking. The rate for the three-week period following our return made a smooth curve with the plotted field rates. In 1926 we were in constant touch by radio with the Naval Station at Cavite, Philippine Islands, and checked these same clocks against time signals nearly every night. At many of the 1925 stations, latitude and longitude observations were taken in 1928, and were found to check most satisfactorily. This, in brief, is the topographic method which Major Roberts developed and followed throughout the summer of 1925. We have no hesitation in presenting his maps as by far the most accurate topographic work that has been done as yet on the central Asian plateau.

DETENTION OF THE CARAVAN

Our camp the evening of Monday, April 27, was sixty miles from Wolf Creek, beside a well on the grassy floor of a dried lake bed. Shortly before reaching this place we saw a Mongol on a camel, who waved to us to stop. He had been sent by Merin to report that our caravan was being held by the border guards, about fifty miles from Ula Usu. They had been there a month, because the guards had found ammunition in our equipment. As a matter of fact, there were several boxes of shotgun shells in one of the cases, but the

Urga authorities had assured me that their permit covered whatever our camels would carry, and that the caravan would be allowed to pass the frontier without examination. Since I knew from previous experience the type of insolent Buriat officials who are in charge of every border station, there was little doubt in my mind as to why our camels were being held. Every Chinese caravan is treated in the same way until the merchants pay enough "squeeze" to satisfy the greed of the Buriats.

The detention of the caravan was a serious blow to all our plans. Instead of having our base at Shabarakh Usu, with rested camels awaiting our arrival, it had covered only half the distance with four hundred miles of the worst desert to cross. It meant that I should have to readjust the entire work of the Expedition.

DEALING WITH BURIAT OFFICIALS

We reached Ula Usu on Thursday, April 30, and found the place little changed since our last visit in 1923. It seemed to be a little more desolate, if possible, but that was all. Still the antelope did not find it so, for thousands of them were scattered on the plain all about us. We had passed herd after herd on our way from Wolf Creek, all of them the grassland species, *Procapra gutturosa*. I have never seen quite as many antelope at any other time as we found that year along our line of march.

A lama came to camp and reported that the soldiers were keeping our caravan so closely guarded at the yamen that the camels had not been allowed to find proper pasturage; that all our boxes had been opened; that the roads were guarded by soldiers; and that when we arrived I was to be taken to Urga and shot. A most interesting prospect! The next morning I took three cars and five men, Granger, Shackelford, Loucks, Young and Lovell, for the drive to the yamen. We were all heavily armed and determined to have the caravan with or without a fight. The Buriats could suit themselves as to which it would be.

Fifty-two miles up the trail we found five Mongol soldiers awaiting us. We unceremoniously bundled one of them into the car as a guide to the yamen, and a short distance farther on discovered one of our own camel men. Twenty-five miles of bad cross-country travel brought us to the yamen. It consisted of two large yurts surrounded by half a dozen tents. Not far away was our own caravan, with the American flag floating in the wind. Old Merin and his Mongols greeted us like joyous children. I found that considerable damage had been done to our supplies, but it was not as bad as we had feared. Half a dozen sacks of flour had been ripped open; several tins in each box punctured and nailed cases pretty well ruined.

As soon as we arrived, an insolent young Buriat from the yamen swag-

gered into the tent and said that I must prepare to leave for Urga in charge of soldiers at once, while the other men and camels remained under guard at the yamen; that the head man would send for me later.

"Tell your chief that *we* are ready to see him *now*," was the reply I sent back. Following closely on the messenger's heels, all six of us approached the yurt. The young Buriat reappeared immediately, saying that the official would not receive us then. I asked Loucks and Shackelford to remain in the cars with rifles ready, and to use them if the Mongols tried to "start anything" outside. Then I lifted the door-flap and stepped inside, followed by Granger, Young and Lovell, with Buckshot and two of our Mongols, Tserin and Aiochi. About twenty Mongols sat in a circle staring at us, fascinated. I said nothing for a few moments and then suddenly demanded, "Who is the head man?" A lama at the far end of the yurt, wearing a gorgeous yellow satin coat and sable-bordered hat, raised his hand.

"How dare you ignore the passport of your government and hold our caravan?"

The lama replied in a low voice that he had found shotgun shells in two of the boxes. I told him that the permit covered everything the caravan carried; that he had opened our boxes without authority; that he had acted like a brigand, and that we intended to take *him* to Urga to answer to the government. At this point I brought my fist down with a bang on the sheet-iron stove. The lama, who had been running his beads faster and faster through his hands, snapped the string and crumpled his rosary into a yellow ball. Finally he managed to stammer that he wanted to pass the caravan, but that his soldier colleague would not do so because it contained ammunition, and also dangerous, seditious literature, in the form of *Asia*, *World's Work*, *Outlook*, *Saturday Evening Post* and other magazines. Moreover, he had discovered a large box of "Eveready" flashlight batteries, which he thought were bombs, and two old Chinese bayonets used by us for digging in fossil beds. Altogether it was most dangerous to the peace of Mongolia!

The lama and all the men in the yurt were so badly frightened that they were anxious only for us to leave with our caravan. I instructed Merin to get ready for an early start next morning, and spent the evening in taking a month's supply of food and gasoline from the boxes. These ignorant officials had made our work extremely difficult. Instead of going west directly upon our arrival at Shabarakh Usu, we should have to remain there until the caravan arrived. I told Merin to travel fast, leaving the weakest camels by the trail. We must sacrifice the animals in order to make up as much as possible of the lost time. Merin thought that he could reach Shabarakh Usu in three weeks, and I gave him twenty-five days as a maximum.

We found the same difficulties whenever we came in contact with the fron-

tier guards. The yamens are on all the main caravan trails, and mounted soldiers continually patrol the border. All of them are Buriats, and I know of no more insolent type of human being than a Buriat in possession of a little authority. Without a show of force, we could get none of them to recognize the passports and permits which I had obtained from Urga at great expense and trouble. Every time we crossed the border we had to let the yamen officials understand that we would enforce our rights, with bullets if necessary. The government officers in Urga were politely regretful when I complained, but did nothing to remedy the situation. As a matter of fact, I think they make no attempt to stop the border yamens from oppressing the Chinese and other traders.

CHAPTER XXIII

A NEW TRAIL TO THE GURBUN SAIKHAN

ACTIVITIES AT ULA USU

THE camels left the yamen on Saturday, May 2. The caravan made a beautiful picture as it moved into the morning mist which hung low above the desert. There were only one hundred and ten camels, as some had been released by the loads of gasoline left at Baron Sog-in-Sumu, near Ula Usu, and remained there for the summer.

We returned to Ula Usu the same day, by a trail which runs from Baron Sog to Gatun Bologai, the spring and oasis that Young and I discovered in 1923. It was considerably better traveling, as well as being more direct, than the Sair Usu road over which we had come. In camp the men awaited our return with the greatest interest, and there was general rejoicing that the camels were actually under way.

Roberts and his assistants had been working hard on a map of the Ula Usu fossil beds. Olsen found a fine titanothere foot and Loucks discovered a complete front limb, but we decided to leave them until our return. Berkey, Morris and Nelson drove to Jisu Honguer for further study of a doubtful geological problem.

Nelson found a series of pictographs, pecked upon the rocks. These were easily recognizable as delineations of human beings, camels, horses and cattle, as well as stags, antelopes, ibex and mountain sheep. I will describe these petroglyphs, and associated mound structures, more fully in a subsequent chapter. Near the camp at Ula Usu, Lovell picked up four iron arrow points, and others were discovered at various points along the route. Doubtless these were early Mongol.

On May 5 we left Ula Usu, going to the obo three miles west of camp, and then across country southward to the trail on which we had returned the previous day. Granger, Chaney and Nelson assisted the topographers. The arrangement worked out well, for the frequent stops for sights enabled Chaney to collect plants along the way and gave Nelson an opportunity to search for

artifacts. They both found many valuable specimens which would have been missed had they continued rapidly with the fleet.

BAIYING BOLOGAI

About two o'clock in the afternoon, when we were forty-three miles from Ula Usu, I was some distance ahead of the others and discovered a fine exposure of red sediments. It was too good to pass without further investigation. A series of five springs, named Baiying Bologai, had formed an intermittent rivulet about which sand-grouse swarmed in thousands. We made camp on a level plateau, with the stream below us. Shackelford and I immediately took posts near the water, with our guns, and proceeded to collect dinner for the camp. I never have had more sporting shooting. With the wind behind them, the birds came in like bullets. I made a record of fifteen birds with sixteen shells. We got forty-two in an hour.

The topographers and others arrived at four o'clock in the afternoon, and after an early dinner all of us scattered over the badlands to prospect for fossils. Before long a number of bones of giant sauropod dinosaurs were discovered, thus identifying the strata as Lower Cretaceous. Unfortunately, the enclosing matrix was of coarse gravel and all the bones were badly broken. After a further investigation, Granger was convinced that anything we might find would be in the same condition and not worth removing. It was evidently a deposit formed by swift-flowing water. Nevertheless, the discovery was important as locating another large area of Cretaceous strata.

Lovell found an owl's nest containing nine white eggs in a rock hole. The disgorged pellets were formed almost exclusively of sand-grouse bones and feathers. The night was clear and cold. From Ula Usu to Baiying Bologai the elevations varied between thirty-seven and forty-two hundred feet.

GATUN BOLOGAI

The following day was cloudy and cold and for the first time the topographers were forced to resort to the compass for obtaining their plane-table set-up. Leaving them to follow, we drove on twenty-eight miles past the yamen. With waving coats the officials tried to induce us to go over to the yurts but I saw no necessity to inconvenience ourselves since they already had seen our credentials. My feelings toward the inmates of that particular yamen were such that were I to write them I would need asbestos paper!

We had tiffin at the base of a bluff where Shackelford discovered a deposit of paper-shales containing plant and invertebrate remains. Although they were rather badly preserved I thought that Doctor Chaney might wish to make a careful study of the locality. I left a note on a stick in the middle of the trail

GRANGER REMOVING A NEST OF DINOSAUR EGGS AT THE FLAMING CLIFFS, 1923.

PLATE LXIII.

ANDREWS AND OLSEN WITH TWELVE DINOSAUR EGGS AT SHABARAKH USU, 1925.

saying that if Chaney desired we would camp for a day at Gatun Bologai. When the topographers reached the spot they delayed long enough for Chaney to make a representative collection of the shales. It was identical with the Lower Cretaceous, Ondai Sair formation at Uskuk, but the plant specimens were not as well preserved as in the latter deposit.

The topographers and geologists arrived at camp at Gatun Bologai at about seven o'clock, having surveyed fifty-eight miles during the day. The run had been over elevations varying from thirty-two to thirty-nine hundred feet. When we left in the morning, sand-grouse were coming in thousands to drink at the spring. The air literally was black with them as they swept down to the water in dense clouds.

Retracing our way six miles, we found a trail which the Mongols assured us ran straight to Artsa Bogdo. The terrain was hard gravel, and except for one bad sand-wash in a field of "nigger-heads" the going was excellent. Thirty-five miles from the road-fork we met our caravan in camp. The camels were doing fairly well, although considerably weakened by their close confinement at the yamen, where they had not been able to obtain proper feed. Merin promised to reach the Flaming Cliffs in a fortnight. Near their camp we saw a well-marked trail which Merin said ran directly to the temple at Sain Noin and the Orkhon River.

Not far from where we met the caravan, I saw one of the small, rare McQueen's bustard, *Chlamydotis undulata macqueenii*, a species which we had first noticed near Iren Dabasu.

TREES AS EVIDENCE OF CLIMATIC CHANGE

In a dry river-bed we found a dozen isolated elm trees. It was always a great cause for rejoicing when we saw trees in the Gobi. One does not realize how greatly one has missed them, and even though they were old and marred by their battle for life still they delighted our eyes.

As I have remarked, the water-table in the desert usually is less than twenty-five feet below the surface, so that it is not remarkable that mature trees are able to reach water with their roots. The significant point is that there are no young trees or saplings to be found at any of the tree-bearing localities in the desert. Since there is no evidence of a change in the soil, the logical inference is that at the present time there is considerably less moisture than in the past when the trees got their start in life. The aridity is so great that saplings are not able to get a foothold. Moreover, only the most vigorous of the old stock have been able to maintain themselves to the present time, and their unhealthy condition prophesies an early demise. This is only one evidence of the minor fluctuations which have occurred within the larger climatic cycles.

BAIYING GOSHIGO

We camped at three o'clock in a dry, sandy river-bed where there were more elms. The elevation was only three thousand feet. It was difficult pitching the tents because of a high wind, which pulled the iron pegs out of the soft ground almost as fast as they were driven in. Close to the trail was a well of excellent water, named Baiying Goshigo. Unlike any other wells that we have seen in Mongolia, this had sides built up six or seven feet above the surface. The camp was fifty-seven miles from Gatun Bologai. We had learned that the topographers under ordinary circumstances could not do more than sixty miles of mapping in a single day and even that brought them into camp thoroughly exhausted. They never had an idle moment when the Expedition was on the march.

Granger and I recognized this well as not far from the spot where Johnson had killed a mountain sheep in 1923. We rejoiced to know that the Mongol information was correct and that the trail would lead us to Shabarakh Usu. During the night Merin arrived with the camels.

COÖRDINATION OF ACTIVITIES WHILE TRAVELING

In order to facilitate work while traveling, the Expedition was divided into two units. Young and Lovell with the two Fulton trucks and Shackelford and I in the touring car were in the advance party. We had with us all the camp-gear and servants and ran ahead as rapidly as possible, breaking trail for the topographers. Wherever there was a particularly bad spot we left a note with directions as to how to negotiate it. In the second unit were the topographers with Chaney and Nelson occupying one car and Granger and assistants in another.

The geologists, Berkey and Morris, who usually remained behind with the topographers, were always kept busy studying outcrops and keeping their route section intact. Sometimes they had to run several miles off the trail to investigate an interesting exposure. Nevertheless, every member of each unit knew where the others were and kept in constant touch in case of trouble. If the geologists had gone a considerable distance off the trail and did not return in a reasonable time, either Granger or Chaney and Nelson went to investigate. It often happened that a car got mired or in such a position that it could not be extricated without assistance. It never was safe to lose contact with any member of the Expedition.

With the advance party I drove a mile or two in front of the others. My job was to pick out a trail, find a way around or through bad spots and thus save the heavier trucks from getting into avoidable difficulties. Also I shot enough gazelle or sand-grouse along the way to provide meat for camp. When we had gone about sixty miles we pitched the tents at the nearest water. Usually

we would arrive about three or four o'clock in the afternoon. The topographers' unit seldom got in before six o'clock and often later. They found camp made and dinner ready.

At the end of the 1925 Expedition we discontinued the use of the Fulton trucks and had an entire fleet of Dodge Brothers cars. The trucks were useful because they were very strong and carried an enormous amount of baggage and men, yet their weight continually got us into difficulties. Often where the lighter cars would run over the surface, the heavier trucks broke through the crust and we had distressing delays and hard work.

A DAY OF HARD WORK ON THE TRAIL

Friday, May 8, was a hard day for all of us. We left the camp by the trees rather late because the sand in the river-bed was so soft that we had to take the cars to hard ground and carry the equipment to them. The first twenty-five miles was fine going but then Young's truck broke through the crust in the middle of a great field of "nigger-heads" and sank to the axles. Getting it out was a slow process. As usual, the only possible way was to collect stones, or anything solid, and put them under the jack by the wheels. As the jack pushed them down others were added. Eventually the foundation was strong enough to bear the weight of the car as the jack lifted it up. Sometimes one of the other cars could give assistance in pulling out a mired car, but as a rule such attempts were useless until there was a firm foundation under the wheels. Hardly had Young's truck been released from its bed of muck when we drove into soft sand. Every car had to be pushed across half a dozen bad spots.

KHUNDELUNGI USU

When we camped after fifty-two miles, at a well called Khundelungi Usu, all the men were exhausted. It was time for some artificial stimulation, and I opened one of the twelve bottles of whiskey which had been brought for special celebrations. None of the fourteen men could have very much to drink from a single bottle, but the mental effect was quite as good as though there had been twice the amount. As a result we had a merry dinner in spite of tired bodies. A terrific wind all day long had added to the discomforts and nerve strain, particularly of the topographers. It was extremely difficult to keep the plane-table steady and get accurate readings. Nevertheless, they had surveyed fifty-two miles and found that the elevations for the day's run were between twenty-nine hundred and thirty-six hundred feet. During the day we crossed a river-bed lined with elms. They were old and gnarled but made a most picturesque avenue as they followed the winding stream course for more than a mile.

SEVENTY-TWO MILES OF ARID GRAVEL

As usual after a stretch of bad going, we found good traveling the next day and ran up and down a series of gentle slopes and across smooth plains, gradually coming up to a height of five thousand feet. The country was so open and the weather so fine that I knew the topographers could get long sights. We expected a record and they made it by surveying nearly seventy-two miles.

The desert was extremely arid all through this region—like a clean-swept floor of gray gravel with hardly a trace of vegetation. We did not pass a well for fifty-four miles. While the terrain was excellent for the motors, I wondered what the camels would find in the way of feed on the hard, bare floor. Merin told me later that his caravan had a distressing time in this region. The only way was to cross the rocky desert as quickly as possible even though the lack of food and water took its toll from the weakened animals. Of course, there were no Mongols in this inhospitable part of the desert.

JICHI OLA

Our camp that night was beside a well on the slopes of a long, low, ragged ridge of sediments called Jichi Ola. The going had been so good that our advance party did the seventy-two-mile run in four and a half hours, arriving at one o'clock in the afternoon, but the topographers did not reach camp until seven in the evening. The surrounding desert was fairly well covered with vegetation and abundant grass grew in the narrow valleys which thrust into the mountain. Three yurts were pitched a short distance from the well and we found their inhabitants most friendly. For gas tins and other small things we obtained a supply of dry argul. "Buckshot" made the best bargain by getting a Mongol to bring up two pails of water from the well and accept, with the greatest delight, two nails in payment. Five or six miles to the north in a field of "nigger-heads" there were half a dozen yurts and a considerable herd of cattle, ponies and sheep. Near the well we saw a fair-sized wild sheep's head and during a walk on the mountain Lovell, Loucks and Tserin saw three rams and five ewes. On the return journey we spent several days here shooting and had a most interesting time.

THE GURBUN SAIKHAN

The next morning we came in sight of the Gurbun Saikhan shortly after leaving Jichi Ola. On either side of the trail were low, isolated and very rough mountain ridges, the easternmost end of what farther west develops into the Altai Mountain chain. The mirage was so well developed that the topographers could not take sights of more than half a mile. Our day's run amounted to only forty-three miles, but under the adverse conditions even that distance gave the topographers more than they could comfortably handle.

CHAPTER XXIV

THE DUNE DWELLERS OF SHABARAKH USU

SPEED AND ENDURANCE OF A WOUNDED ANTELOPE

On the way to Shabarakh Usu next morning, we had a surprising exhibition of the ability of a gazelle to run when badly wounded. I shot a young buck, completely severing the hind leg at the knee. The animal continued to run at a speed of twenty-five miles an hour for five miles. The going was so bad that the car could not reach a greater speed than that and we were not able to get near enough for a second shot. Two wolves also gave us an exciting chase but we lost them in a series of deep ravines.

RETURN TO THE FLAMING CLIFFS

Late in the afternoon we reached the eastern end of the great Shabarakh Usu basin. My car was in the lead and I had worked up to the opposite slope before the others picked their way into the chasm. They looked like tiny black ants on the surface of a great red wall. One could not conceive of them as automobiles. Evening shadows already had transformed the vast pink basin into an unreal place. Like a fairy city it is ever-changing. In the flat light of midday the strange forms shrink and lose their shape; but when the sun is low the Flaming Cliffs assume a deeper red, and a wild mysterious beauty lies with the purple shadows in every canyon.

There had been little change since we left in 1923. The tracks of our motor cars were filled with sand but still distinct; the old camp site on the basin's rim was marked by a heap of discarded stone blocks, each containing an incomplete skull of a dinosaur which had lived there in the far dim past.

Our tents were pitched on the basin floor near the well. I loved the spot, for I had only to raise my eyes to see the sculptured ramparts of the Flaming Cliffs shimmering in the Gobi mirage. A few hundred yards to the north was an area of old dead sand-dunes now dotted with a "forest" of so-called tamarisks, *Salicornia herbacea*. These are stunted desert trees which really are not tamarisks at all. They are under fifteen feet in height, yet Doctor Chaney found by sections that many of them were more than two hundred years old.

We were all very tired from the continued traveling, and I announced that the day after our arrival, May 12, would be one of rest. We could shave, bathe, cut hair, read and write to our hearts' content. But few of the men could loaf for a full day in such an interesting spot. Shackelford was busy with his camera, Nelson wandered off into the sand-dunes and Granger gave the fossil beds "the once over." He reported that the two seasons of rain and frost and blasting gales had removed a good bit of surface sediment and that there were excellent chances of new palæontological discoveries.

DUNE DWELLER ARTIFACTS

Shackelford had been looking about in the "tamarisks" during the day and reported finding many artifacts. In the evening I walked over to the dunes and into a shallow valley, the floor of which was thickly strewn with such specimens. The next morning Nelson and I went out immediately after breakfast, followed by Berkey, Morris and Loucks. We found an area of dead dunes which had been "anchored" by the small trees. Sculptured red bluffs marked the entrance to shallow valleys floored with soft sandstone where the wind had swept away the loose sediment.

On the clean surface, flakes of red jasper, chert, chalcedony and other white stones were scattered like new-fallen snow. Pointed cones, neatly shaped where flakes had been stripped off, tiny rounded scrapers, delicately worked drills and a few arrowheads gave Nelson the first indications of the type of culture with which he had to deal. We held a consultation. "Where did the artifacts come from? Could they have been washed down from the surface?" These were the first questions to be answered. We must find flints actually in the rocks and bones to date the deposit geologically.

Shortly after our consultation I discovered a bit of eggshell of the giant ostrich *Struthiolithus*. A few yards to the left Morris found another fragment of shell drilled with a neat round hole. Nelson said it was one of the beads in a necklace. We were in a fever of excitement for the trail was getting hot. Nelson, the most conservative of conservatives, was skipping about from place to place like a boy of sixteen. At last Berkey found a spot where half a dozen chipped flints were deeply embedded in the sandstone floor. We made much of him for his discovery only to find that it had already been marked by Shackelford the previous day. Before noon we had discovered a dozen such spots and were satisfied that some, at least, of the artifacts had weathered out of the lowest level and had not washed down from the surface of the dunes.

An unlooked-for complication entered when we began to discover fragments of pottery. It was primitive enough, to be sure, but a people who used such crude stone implements had no business to be making pottery! The problem became more interesting and more complicated every hour.

I have never seen the advantages of correlated work more clearly displayed than in solving this human problem. The geologists, palæontologists, topographers and botanist all assisted the archæologist. Without such a combination of expert knowledge *available on the spot*, it would have been impossible to settle many of the puzzling questions presented by this deposit. The subject became so interesting that it was difficult to keep all the men from hunting artifacts. Doctor Loucks was one of the most enthusiastic workers. In company with Doctor Berkey, he discovered a vast workshop where flint chips were scattered over the surface in tens of thousands. They took four of our Mongols to the spot one morning and returned with about fifteen thousand flakes. Nelson was busy for days sorting the pile and selecting such as were valuable for specimens.

The second day's work revealed dark spots in the lowest layers of the soft red sandstone. Evidently these were ancient fire sites. When they were dug through in cross sections, layers of ash containing charcoal, flints and burned bones were revealed. Very soon we found square bits of dinosaur and ostrich eggshells embedded in the sandstone. It was then that we realized that these Dune Dwellers were the original discoverers of the dinosaur eggs. About that time Doctor Loucks found quantities of the ostrich eggshell on the surface of the peneplane. Evidently these primitive people picked up both the ostrich and dinosaur eggshells at the Flaming Cliffs two miles away and brought them to their workshops here in the dunes. A few mammal bones were found embedded in the flint-bearing strata but they were so poorly preserved that identification was impossible.

PRACTICAL JOKES

On the second day after a good many flints had been found *in situ* and Nelson had come to the conclusion that we were dealing with a Mesolithic culture, Doctor Chaney played a joke which was most amusing. He found a bit of rusted iron saw blade and planted it neatly in the flint-bearing layer. Doctor Berkey was the one who discovered it first. This caused utter consternation. It completely upset all our theories and gave us a bad hour. But while we were sitting disconsolately about the spot racking our brains to account for its presence, Nelson strolled up and produced the other part of the blade which he had found near camp!

We determined to get even with Chaney. He was an enthusiastic collector of bird's eggs and spent every leisure moment blowing and labeling them. Shackelford and I got two well-matched hen's eggs and had the cook boil them hard. Then they were beautifully stained in potassium permanganate. I found a bush near the sand-dunes where the ground was splashed with bird-droppings, scooped out a hollow depression and "set" the eggs. A pair of

demoiselle cranes lived near the spot and I told Chaney that probably there was a nest in the vicinity. He never had seen a crane's nest or eggs so that the rest was easy. When I returned to camp and announced the discovery he was all excited. Four of us piled into a car and ran down to the spot. He was so delighted that I almost relented. Then I remembered the saw and hardened my heart. After Chaney had photographed the "nest" from three angles and made a close-up with the portrait lens, we went back to camp. Word had been passed around and eight or ten men gathered to see the denouement. First attempts at blowing were not successful and after a serious discussion as to the best method of preservation he decided to remove the embryo through a hole in one side. I never will forget the expression on his face when he discovered that they were hard-boiled! With a roar he hurled one at Mac Young and the other at me, but we already had a good start across the desert.

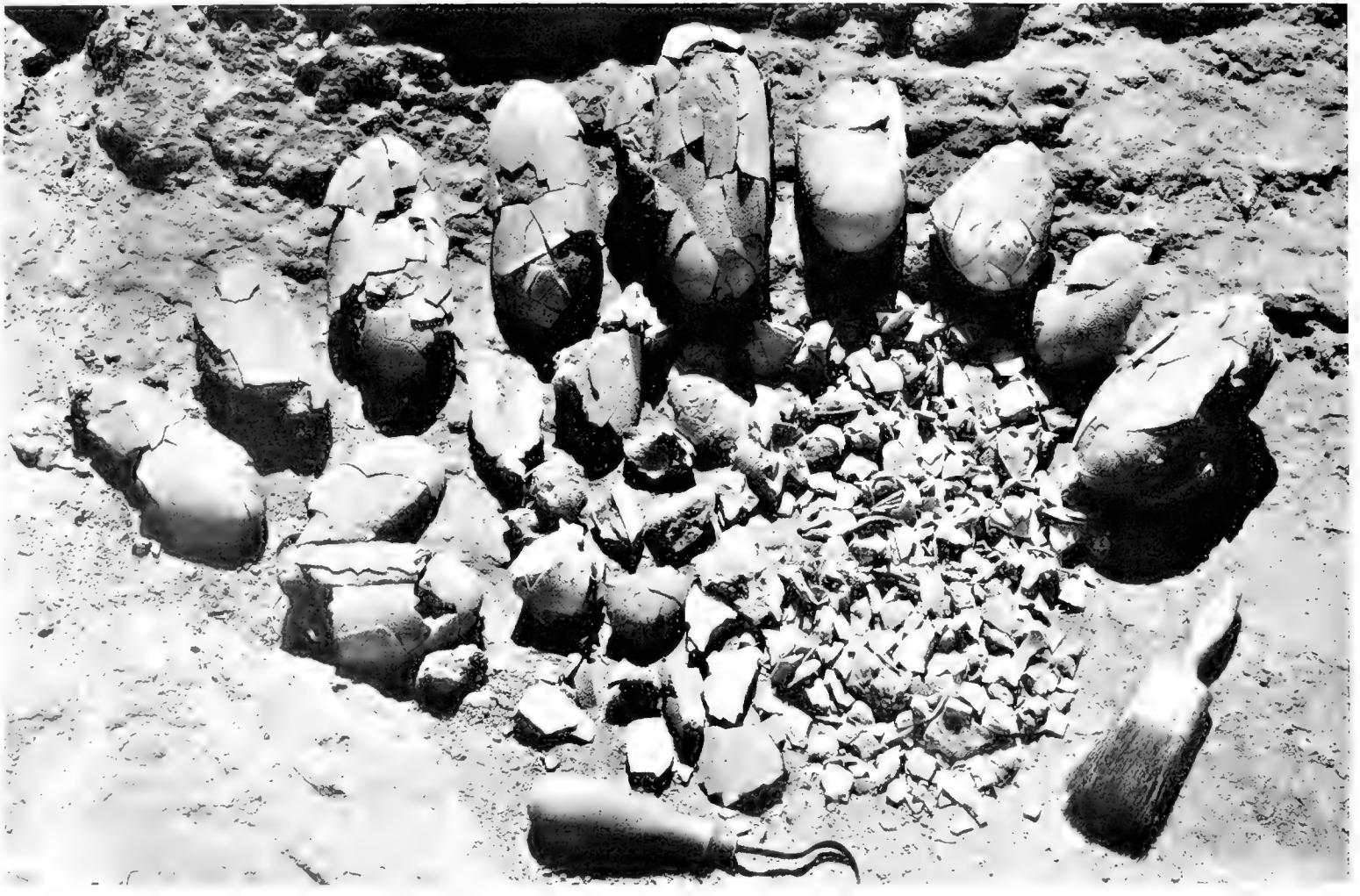
Practical jokes on an expedition may lead to bad feeling, but Chaney was a good sportsman. He knew that he deserved all he got after the episode of the saw. Still, he assured me that I headed his list of preferred funerals and that sooner or later I would "get mine." I did, too. It was when we were eating the last of the twelve hundred eggs that we had brought into the field. An innocent-looking, but previously prepared boiled egg was served me at breakfast and when I broke the shell a flood of pink water soaked everything on my plate. Then all debts were paid.

PALÆONTOLOGIC AND TOPOGRAPHIC WORK

While every day was bringing to light fresh information regarding the new human culture, the other work of the expedition progressed just as satisfactorily. The day after our arrival Buckshot and Liu each discovered fine *Protoceratops* skulls and the topographers had begun a detailed map of the basin. Chaney explored a bluff to the north of the sand-dunes where he found a deposit of shale containing poorly preserved plant remains and some wood. In a basin to the east, Granger also found wood which had been converted into charcoal by burning, probably in the course of an ancient forest fire started by lightning. The trees were of fair size, the largest two feet in diameter. Doctor Chaney is convinced that during the Cretaceous the climate of this region was too dry for the preservation of many plants.

MORE DINOSAUR EGGS

Olsen was particularly anxious to find more dinosaur eggs, and shortly after our arrival he discovered a beautiful set of five in a most unusual way. He was prospecting in the gully where he had discovered the first eggs in 1923. Not thirty feet from the site of the original nest, he saw a bit of shell fragment in the loose sand; a few yards farther up the slope was a larger piece—then no



A NEST OF DINOSAUR EGGS DISCOVERED BY GEORGE OLSEN AT SHABARAKH USU, 1925.

PLATE LXV.

B. RESTORATION OF YOUNG DINOSAURS EMERGING FROM EGGS.

more. Crawling on hands and knees he went over every inch of ground, but there was not a trace which could lead him to expect the presence of more eggs. Impatiently, he drove his pick into a cracked rock, overturning a chunk weighing fifty pounds. Adhering to the under-side were five dinosaur eggs, three of them unbroken. The fourth was cracked and the end of the fifth fitted the fragments which had led him to the nest. The discovery was pure accident because Olsen does not often waste time and energy in turning over rocks when he cannot see fossils. These eggs were much smaller than those we had found in 1923 and evidently were laid by a different type of dinosaur. They are now in the Field Museum of Natural History, Chicago, Illinois.

Another accidental discovery of dinosaur eggs was even more remarkable. Norman Lovell was interested in getting young birds for pets. One day he saw a kite's nest just under the edge of the cliff that terminates the great peneplane which sweeps down from the Gurban Saikhan and stops at the basin. After several unsuccessful attempts to climb the face of the cliff, he gave it up and approached the nest from the plain "to see what he could see." Crawling on his hands and knees to the very edge, he lay flat on his stomach trying to peer into the nest, when his hand struck something sharp. It was the knife-like edge of a broken dinosaur eggshell! The upper parts were gone but the remains of eighteen eggs were in their original position firmly embedded in the rock. Perhaps in another few months of weathering this section of the basin rim would have broken away and the eggs smashed to bits on the rocks below. There was nothing but pure luck in the discovery because the only eggs in Lovell's mind were those of the kite which he expected to see in the nest below.

It was a delicate and dangerous operation to remove the eggs. A high wind blew the entire time, and Walter Granger had to lie at full length to avoid being swept over the brink. He took out the block of stone containing the eggs and it was sent to the Museum entire. Although the exposed surfaces of the eggs are weathered and broken, the lower halves are intact and they make a superb exhibit. The eighteen eggs in the block stand on end in a rough double circle. Doubtless the nest originally contained more, for there was evidence that others had broken out as the edge of the cliff crumbled away. East of the Flaming Cliffs, Chaney picked up seven hundred and fifty fragments of dinosaur eggshell in one spot.

A NESTING SITE FOR GIANT OSTRICHES

Even the topographers did their bit for palæontology, for while mapping the sand-dunes Robinson found many bits of *Struthiolithus* shell embedded with worked flints in the lower sandstone layer. We were curious to know why these ostrich egg fragments should occur in such numbers in a single

locality near the top of the peneplane. I went out with Berkey and Loucks, who had discovered the spot. We found what Berkey is confident was an ancient basin of redeposited Pleistocene sediments which probably made an excellent nesting site for the giant ostriches.

SEVERE SANDSTORMS

On May 11 and 16 there were such furious windstorms that it was quite impossible to leave camp. We could neither work, read nor write—nothing in fact but find whatever spot offered the maximum of shelter and sit there with faces wrapped in wet cloths. As usual after a really bad sandstorm, the following day dawned without a breath of wind and with crystal-clear air. The sand and gravel being heavy do not remain suspended, and the wind seems to "wash" the atmosphere of all haze and fine particles of dust. The staff took up their interrupted operations with eagerness, and during the next four days the camp was deserted except at meal times.

A NECESSARY TRIP TO URGA

I had received word that the Government officials insisted that I come to Urga. New regulations had been passed which required discussion if we were to continue our explorations. It was extremely annoying to have to leave the Expedition when we were in the midst of such interesting work, but there was no alternative. I decided to go up with McKenzie Young on May 24, and finish the disagreeable business as soon as possible. From Shabarakh Usu we estimated the distance to Urga at about three hundred miles. The Mongols said that a small trail ran northward and that eventually it joined a well-marked caravan road which led to the capital. Even without trails we felt sure that we could find the way easily enough, as we got exact compass directions from Major Roberts. We decided to take only one car and Tserin, our usual Mongol companion.

A MAY SNOWSTORM

The twenty-third was a beautiful summer's day. The Flaming Cliffs whirled and danced in the heat-waves reflected from the basin floor. Beside the tent a huge black raven drowsed upon a rock with beak half open, and even the spotted lizards were too sleepily content to snap at the tiny sand-flies which crawled incautiously beneath their pointed snouts. It was so warm that as Young and I prepared for our trip to Urga we thought only of the lightest clothing. But when we left next morning a raw wind was blowing from the north. Summer had departed in a night and it kept on going every hour. By noon the car could barely make headway in the teeth of an icy gale which whipped sand and gravel against our faces like bursting shrapnel. We have

had too much experience with Mongolian weather to start on any trip without fur coats, but even in these our teeth were chattering.

At seven o'clock in the evening when we saw a lone yurt beside the trail, both of us had had more than enough. The only inmates were a young lama and a wrinkled old hag, aged seventy, with a baby of four or five years. But they made us welcome and piled dry argul upon the fire until our numbed bodies had begun to warm. In half an hour the mother of the baby arrived—a strapping young Mongol with a frame like a football tackle. She had been out all day searching for a flock of sheep while the man toasted himself at the fire. When more argul was needed he never dreamed of moving but told the old grandmother to bring it from the pile outside. Tserin pitched our tent close to the yurt with the aid of the lama. Cold antelope meat, a tin of sweet corn, coffee and biscuits made our dinner. We were too tired to be hungry, but the steaming coffee was better than the most wonderful wine. The circular felt-covered yurt was like all others. On a red chest opposite the door stood a Buddhist picture and a few sacred family treasures. At one side was a platform bed raised four inches off the ground; the man slept on it, of course, while the women had two rolls of felt nearby. On the other side of the yurt was a wooden rack holding bowls of curdled milk; close beside it two calves and half a dozen baby lambs and goats tied to a rope. The yurt reeked with mingled odors of mutton fat, rancid butter, unclean Mongol and living goat, but it was *warm*.

Of course our tent had been pitched with its back to the gale but during the night the wind made a complete shift. When I awoke in the morning I had the strange feeling of a heavy weight pressing me down. Opening my eyes I could see only white. Then I slowly began to realize that I was buried in a snowdrift. I managed to sit upright and saw only a great white pile where McKenzie Young ought to be. At my call, strange heavings took place and McKenzie sat up looking wildly about at the unfamiliar surroundings. The tent was packed solidly with a drift which in the back reached right up to the ridge pole. All our clothes were buried deeply somewhere in the snow, and to put the cold, damp garments on our warm bodies was anything but pleasant. The front of the car had been covered with a canvas hood. When McKenzie started the engine a peculiar muffled roar came from the interior. He found it was as solidly packed as though we had shoveled snow inside.

It was eleven o'clock before we finally got away from the friendly yurt and began to fight our way toward Urga. That day was a constant battle. Often when plowing through the white blanket on a smooth plain, the car would suddenly drop into a ravine packed six feet deep with snow. It was a terrible, sickening feeling when everything seemed to go out from under us. Then there was nothing for us to do but to dig around the car till it reached the

ground, jack up the wheels and pave a road with stones until we could get out. Poor McKenzie had to bear the brunt of all the work, for my right shoulder was still virtually helpless from a crash in the New Year's steeplechase at Tientsin, when I had torn my collar-bone away from all its fastenings. I was of use only to pick up stones or drive.

With the greatest difficulty we had worked our way across two ranges of high hills but stuck badly near sunset, half-way to the crest of a mountain pass. Two hours of heart-breaking work got us out of the ravines and we drove up to a Mongol yurt in the curve of the lower hills. The warmth and shelter of the tiny felt house were glorious even though we shared it with goats, calves, men, women and children, who watched our every move with fascinated eyes. Next morning we awoke to gorgeous sunshine, but the trail was deep in snow and we had to work far up the grassy slopes, circling and twisting to avoid the drifts. The tires slipped on the wet grass, and the car would move forward only where we built a path of stones. After five hours of dangerous and strenuous work, we were only three miles from our night's camp. But our troubles were at an end when we gained the summit of the pass and drove down the steep slope into a beautiful valley. There we got back to the trail, which became broader as we approached Urga.

In the snow-filled ravines lay the bodies of horses and cattle that had been caught in the white death-traps. Some of the animals were too weak to move and gazed at us with pitiful eyes. I longed to end their sufferings with a bullet, but it would only have meant trouble with the Mongols. That blizzard took a frightful toll of life all across the northern grasslands, for it came so suddenly that the natives were unprepared.

ARRIVAL IN URGA

From the crest of a hill Urga lay below us like a beautiful jewel set in the green valley of the Tola River. We could see the sparkling roofs and golden cupolas of the Living Buddha's palace nestling in the silver poplars at the base of Bogdo Ola, "God's Mountain." Towering above the city was the great temple surrounded by the cubicles of ten thousand lamas. Peaceful enough it looked in the spring sunshine, but I knew that it was a city of suspicion, and one not to be entered without due thought of how one was to get out.

We had been especially invited to come to Urga by the governmental Scientific Committee. One object of our visit was to unpack and install for them a large collection of fossils which the American Museum had presented. It included a replica of the giant *Baluchitherium* skull and of the famous eggs. In spite of arrangements which were supposed to have been made on our behalf, we were subjected to merciless searching of our persons and belongings,

PLATE LXVI.

EXPEDITION CARAVAN ARRIVING AT FLAMING CLIFFS, 1925.

A. [illegible] DUNE DWELLERS AT DAGHOSHA AWAKIL [illegible] 1925

B. TYPES OF IMPLEMENTS MADE BY DUNE DWELLERS

and every scrap of writing and all books were sent to the Secret Service office to be perused by censors.

FRIENDS IN URGA

It was almost dark when we escaped from the last yamen and reached the house of Mr. Percy Marshall, Manager of the International Export Company's Urga branch. A warm welcome awaited us from Mrs. Marshall, although her husband was away. Oscar Mamen, then in the employ of the Mongolian Coöperative Company, arrived from Kalgan only a short time after we reached the house. Mr. Johannsen, a Danish trader, from Uliassutai, was another guest. The Marshalls' house was the one bright spot in Urga. It was substantially built of logs, comfortably furnished, and Mrs. Marshall had given that touch of feminine charm which can come only from a woman of refinement. John T. McCutcheon, the famous cartoonist of the *Chicago Tribune*, and Mr. Barney Goodspeed with their wives had left for Kalgan the day before. We had hoped to see them, but they could wait no longer and started just in time to meet the blizzard which we encountered. Fortunately for them there was much less snow in the east and they got through with only two days' delay and comparatively little discomfort.

UNCERTAINTY OF URGA "LAWS"

The morning after our arrival we discovered that all the arrangements which I had made in 1924 with much labor and expense had been nullified by "new regulations" passed during the previous month for our especial benefit. "Laws" of this sort were mushroom growths which were rapidly ruining trade with Urga. When a caravan of cigarettes reached the outer barrier at Mai-mai-cheng and before it had passed the first inspection new regulations might be promulgated raising the duty on cigarettes fifty per cent. This actually happened in dozens of instances with various kinds of goods. As a result the merchants never could tell whether they were to face a profit or loss on any shipment. In 1924 I had spent about three thousand dollars and nearly a month of time in making arrangements for the Expedition. All of it was lost and it was necessary to begin at the very beginning. As usual, Mr. Badmajapoff was of enormous help.

THE DEMANDS OF THE MONGOL GOVERNMENT

The Mongol Government presented impossible demands. We were to be required to bring all our collections to Urga, where the Scientific Committee was to take whatever it wished. No maps of any kind could be made and no geological work done. Moreover, the Mongol Government was to designate two students who were to be sent to America and educated at Harvard Uni-

versity entirely at the Expedition's expense. It required days of talk and negotiations before a reasonable agreement could be reached. In the meantime we were under constant espionage. Tricks of various sorts were resorted to, whereby the authorities hoped that we might do, or reveal, something which would show that our scientific work was merely a camouflage for some sinister design. I must say, however, that I can hardly imagine more clumsy attempts of surveillance than the Secret Service instigated in our case. The first day the poor spy who was detailed to follow us was nearly exhausted, because on foot he could not keep pace with our rapid trips in the motor car. Therefore I invited him to occupy it with us, much to his enjoyment. He turned up at nine o'clock every morning to relieve the agent detailed to watch the house at night. Two hours of continued questioning at the Secret Service office netted them nothing, and with the greatest reluctance they had to admit that we appeared not to be as potentially dangerous to the safety of the country as they had hoped.

A SECOND MEETING WITH GENERAL KOZLOFF

One very pleasant break in our stay at Urga was again to meet General P. K. Kozloff and his charming wife. They had been in Peking and returned with Mr. Marshall. The evening of their arrival I walked over to the tiny house in which they were staying and found the General and his wife in the midst of skinning a dozen large hawks. These they had collected on the way to Urga and had started their preparation before resting or having dinner. Such enthusiasm in a man, then sixty-six years old, was a splendid inspiration. Kozloff was preparing for his expedition to Kara Khoto which had first been delayed by orders from Moscow and then by his subsequent discovery of Tang Dynasty tombs in the forests north of Urga. We made plans for our two expeditions to meet at the Altai Mountains near Shabarakh Usu, but they did not materialize. Kozloff was again delayed and did not leave Urga until late in the autumn.

THE URGA GOVERNMENT PERMITS RECEIVED

On June 4, the last document had been signed, the last permit received and the last dollar paid. I felt that I should go mad if I had to make another visit to the yamens. The agreement which we finally signed with the Scientific Committee was fair and provided that certain duplicates of our collections should be returned to Urga.

Nevertheless, we were required to take two Secret Service agents with us on the Expedition. One was openly to report our movements; the other masqueraded under the guise of a member of the Scientific Committee. All this after we had already conducted two seasons of exploration in Mongolia, and

the entire world knew what we had accomplished! It was annoying to have the two Buriats with us, as I felt sure that through ignorance and misunderstanding they might cause us trouble. My fears were realized.

SCIENTIFIC COMMITTEE REPRESENTATIVES

When we concluded the negotiations at Urga, it was five o'clock in the afternoon, but there was still time to get through the barriers and well out upon the open plains before dark. On leaving Urga we were joined by the two Buriats who rode with Tserin on the top of the loaded car. One was Dalai Badmajapoff, whom we took at the request of Mr. T. Badmajapoff, as a guest of the Expedition. He spoke excellent English and was a very nice boy. We were glad to have him. The other was the representative of the Scientific Committee, John Dimschikoff. He was a "professor" in one of the schools. The subjects which he "taught" included every known branch of science. Since he was only twenty-four years old, there were still a few things which he had not learned, but he would not admit as much.

Dimschikoff had also been commissioned by the Secret Service as a confidential spy to ascertain from our daily conversation what were our real motives in coming to Mongolia. Since he could speak only a limited amount of English, he understood just about half of what we said. He evidently thought that he would gain much credit if he "discovered" something startling regarding us, and sent in reports of the most amazing character. One of them was to the effect that Mr. Gordon Vereker, First Secretary of H. B. M. Legation, Peking, was a member of the Expedition in disguise. Mr. Vereker had accompanied me to Urga the previous autumn merely for the experience of the trip. Dimschikoff reported that he had learned from our conversation that America and England were planning to combine for the purpose of annexing Mongolia. There was much else in the same vein. The Secret Service in Urga were only too ready to believe Dimschikoff's reports, but Badmajapoff persuaded them to wait. When Dalai and John returned, the former repudiated all that the latter had written. However, except for the fortunate circumstance that by that time we had passed beyond the frontier of Outer Mongolia, we should have been arrested and taken to Urga.

The Secret Service sent another man who joined us later when we were at Tsagan Nor. He was a very decent fellow, and his reports with Dalai's confirmation completely discredited the wretched Dimschikoff. Evidently the latter was sent away from Urga to his home in Siberia because of the reports he had manufactured concerning the Expedition. Two years later he had sufficient influence to be allowed to return to Urga and was sent to Germany with Dalai. He stole the money for their expenses and poisoned Dalai. He then reported that the latter had taken the money and committed suicide when

he, Dimschikoff, discovered the theft. Our experience with Dimschikoff is an excellent example of what unfortunate results may happen when an expedition is forced to take such men into the field. As a rule they do not have the interests of the expedition at heart; on the contrary they feel that they can win recognition for themselves by creating trouble. If the Leader were allowed to choose the men who were to accompany him, it might be a very different matter.

CHAPTER XXV

THE DUNE DWELLER CULTURE AND CRETACEOUS MAMMALS

THE RETURN FROM URGA TO SHABARAKH USU

Our return to Shabarakh Usu was very different from the northward trip when we fought snow and cold at every mile. Spring had come again and brilliant sunshine flooded the grassy hills. We passed a dozen lakelets dotted with breeding water-fowl. From the shore of one rose the sheer wall of a granite mountain, warped and folded into grotesque shapes. Late in the afternoon of the second day the grass began to thin; turf was replaced by fine gravel, and we realized that we were entering the northern edge of the desert. Our camp that night was only eighty miles from the Flaming Cliffs. We hoped to reach Shabarakh Usu by ten-thirty in the morning, for the vast peneplane was like a floor, but blow-outs of two of our tires halted us under a ridge less than two miles away. With field-glasses we could see the blue tents steaming in wavering lines along the heat-soaked plains or dancing in a graceful mirage above the basin floor. We gave our emergency signal of three rapid shots, but the men in camp could not discover us in the fluid sunlight.

Leaving McKenzie with the car, I walked in toward the tents through the grove of stunted "tamarisks" on the dead sand-dunes. I was amused to watch the reaction in camp at my arrival. One of the Chinese servants first discovered me. Shading his eyes, he peered intently, then called another boy. At last they were convinced that it really was I. Then Lovell burst from his tent, followed by Shackelford and Robinson. Anxiously they ran to meet me, thinking that some accident had happened, but I shouted that all was well and to send out a car with extra tires for Mac.

It was good to be back in camp. A fortnight had passed since we left, and it was like reading an absorbing novel to hear the story of what had happened during my absence. Most of the men had gone for a day's trip to the Gurbun Saikhan, but I heard an outline of events from Shackelford before he read his mail. More dinosaur eggs had been found. The excavation of Lovell's nest had been completed, and Doctor Loucks had discovered another "setting" of

very small thin-shelled eggs quite unlike any of the others. Nelson's work on the new human culture was ended. They had located a dozen other artifact sites and had cut through many fireplaces but no human bones were discovered. Berkey and Morris had come to the conclusion that the flint-bearing deposit in the dead sand-dunes represented a new geological formation, which they named the *Shabarakh formation.*

ORIGIN OF THE SHABARAKH USU BASIN

The way in which the basin at Shabarakh Usu was made is so interestingly and clearly stated by Doctor Berkey that I quote his remarks in full:

"At Shabarakh there is an ancient river valley eroded to a depth of over 400 feet below the general level of the Gobi planation surface. It could not have been made under present climatic conditions. There must have been enough of a stream in some former time to do this work. Now there is no stream at all. Closer inspection shows that the sediments, now well exposed by present-day erosion, which is accomplished chiefly by the wind, are not the same as those forming the sides of the valley into which the river trench is cut. Whereas the strata of the valley side carry dinosaur bones of Cretaceous age, these sediments in the valley bottom carry only fragments of modern forms and human artifacts. The differences in lithologic character of the two lots of sediments throw further light on the matter. The valley bottom material exhibits evidence of deposition under rain wash and torrential conditions alternating with spells of wind action and with development of dune sands as time went on. The lower beds are therefore dominantly torrential sands, alternating with silts laid down in small ponds of standing water, whereas the higher beds show more and more the features of windblown material.

"Topographically the valley bottom shows certain abnormalities also. The cross profile of the valley is not regular and the longitudinal profile and gradient are likewise more irregular than one should expect for a valley eroded in uniform sediments. These irregularities suggest obstruction of the valley by deposits of some kind.

"Clearly the whole series of observations coupled with those made in the adjacent Altai Mountains, which there is not space to discuss, support the following explanation. The original Shabarakh valley was eroded to its maximum depth under much more humid conditions than at present. There was enough rainfall to maintain an active river, and to support vegetation on the valley slopes which were thus protected from excessive rain wash and under these conditions maintained a smooth outline. But there came a permanent change of climate that has prevailed with only minor variations ever since that time. The region became more and more arid and there was insufficient water to maintain enough of a stream to continue valley erosion. Increasing aridity

resulted in destruction of vegetation so that the valley slopes became bare and thus lost their protection against attack by the infrequent rains and the more constant winds. The occasional rainstorms therefore caused excessive wash of soil from the steep valley sides, and this debris collected in the valley bottom, whence it could not be removed by the reduced stream. In the intervals between storms the winds whipped the dried sands about and piled them into dunes and shifted them along the valley bottom, thus adding to the irregularity of distribution. This combination of processes must have continued for a long time for the valley bottom became more and more heavily covered and obstructed with these deposits.

"The increasing aridity resulted first in the loss of permanent stream flow, but for a time there were still struggling streamlets and transient pools dammed in by the obstructing wash from the valley sides. In these pools the finer sediments were collected, but ultimately even these ponds were dried up, so that there was water only occasionally after a storm or during the rainy season. Finally, after layer upon layer of such deposits had been accumulated, the climate became so much more arid that even the rain wash from the valley sides was not sufficient to balance the destructive work of the wind, which with perhaps increasing vigor continued its attack on the lower sand. So effective and dominant had wind erosion become by this time that the finer sands were carried entirely out of the valley and the attack continued on the underlying deposits. Thus erosion has continued with short periods of reversed conditions down to the present day. This deposition history, followed by the reversal of operations from deposition to erosion, is fully recorded in the bare and much dissected remnants of strata where one can see every structural detail.

"These are the deposits in which and on the surface of which the artifacts registering the occupation of man have been found at Shabarakh Usu. A primitive race of men lived in the valley bottom along the course of the ancient stream. As the conditions changed on the last great cyclic swing toward a warmer and more arid climate, they gathered in the valley bottom, the only place where water could be obtained, and in this way they held out for a long time against the increasing privations of the encroaching desert. Repeatedly the sites of their hearths and workshops were flooded and overstrewn with wash from the hillsides due to a sudden storm, and the products of their workmanship were covered to become part of the permanent sedimentary deposits. Such experiences must have continued for some thousands of years until the accumulation filled the whole valley bottom to a depth of probably a hundred feet.

"The deposits formed during this time therefore carry evidences of the culture of a long period of time. In this connection it is especially important

to note that the artifacts of the lower beds are of a much more primitive type than are those in the upper layers. Not by any means all of the original deposits are exposed to inspection; the oldest and lowest beds are still covered and the highest ones have been destroyed; but a cross-section of the intermediate members is open to inspection. As a consequence, of course, the earliest stages of the human history of the locality cannot be read here because the records are still buried; but the later steps are marked by finds still in place in successively higher and higher layers of deposits; and the very latest stages, which must have been recorded in overlying beds that are now destroyed, are mixed together in the jumble of residuary debris left from the selective erosion work of the wind. At such places these relics of the handiwork of prehistoric man may be found literally by the thousand."[1]

THE PRIMITIVE CULTURE OF THE "DUNE DWELLERS"

Because of the fact that these primitive people inhabited the sand-dunes of the desert, Mr. Nelson named them the "Dune Dwellers" and says:

"*III. Mesolithic.* This stratum alone yields a combination of traits which, so far as known, may be termed distinctively Gobian. Moreover, its normal occurrences in old, dead and indurated sand deposits, named by Messrs. Berkey and Morris, the Shabarakh formation, is so striking and distinctive that we venture to designate it the Shabarakh Culture. The stratigraphic position of this Shabarakh Culture makes it positively pre-Neolithic; and the chipped stone (mostly red jasper) artifacts by which alone it is known, in several specific details conform closely to the Azilian flint industry of Western Europe. The inventory is as follows:

1. Hammerstones, mostly roundish adaptations. Scarce.
2. Cores, or nuclei, slender, crude, multi-faceted, angular and spherical. Numerous.
3. Cores, or nuclei, slender, oblong, cylindrical to conical in outline with sometimes a sharp projection on one side adaptable for cutting purposes. Numerous.
4. Flakes, various forms, broad angular or subtriangular, with no retouch or indication of use; serviceable as knives, etc. Derived from Core No. 2. Very numerous.
5. Flakes, long slender, prismatic, and often very delicate, with little or no retouch or sign of use; suitable as drills, gravers, knives, etc. Derived from Core No. 3 by pressure process. Very numerous.

[1] Berkey, Chas. P., and Nelson, N. C. 1926. "Geology and Prehistoric Archæology of the Gobi Desert," *Amer. Mus. Novitates*, No. 222, pp. 7–8; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 67, pp. 1–16, 1930.

PLATE LXVIII.

EXPEDITION CARAVAN LEAVING SHABARAKH USU, 1925.

PLATE LXIX.

A. A SNOW-COVERED PASS SOUTH OF URGA, 1925.

B. ANDREWS AND YOUNG IN A SNOWDRIFT ON THE WAY TO URGA, 1925.

6. Perforators, produced by trimming or secondary chipping of flakes from either of the above groups. Rare.
7. Retouched flakes, various forms, of uncertain purpose but of use as knives or scrapers. Moderately numerous.
8. End-scrapers, small, mostly thumbnail size, round to oblong, some double-pointed, distinctly Azilian. Very numerous.
9. Disk beads of *Struthiolithus* eggshell (occasionally dinosaur eggshell) in all stages of preparation, from rough ar gular fragments to drilled and ornamented examples. Finished forms scarce.

"*IV. Neolithic.* This stage is an outgrowth, with modifications and additions, of the preceding Mesolithic. The two agree also, for the most part, in mode of occurrence; but the geographic range of the later Neolithic horizon would seem to be considerably greater. The outstanding traits include the following:

1. Hammerstones, ordinary roundish. Scarce.
2. Grinding slabs of stone, thin, rubbed surface. Scarce
3. Rubbing stones, flat, oval outline. Scarce.
4. Mortars, globular. Scarce and even doubtful.
5. Celts or axes, flaked surfaces with slight amount of polish near cutting edge. Scarce.
6. Adzes or gouges (perhaps scrapers with curving edge), chipped surface. Scarce.
7. Cores—as under III, 2. Numerous.
8. Cores—as under III, 3. Moderately numerous.
9. Flakes, ordinary—as under III, 4. Numerous.
10. Flakes, prismatic—as under III, 5. Moderately numerous.
11. Perforators—as under III, 6. Moderately numerous.
12. Worked or retouched flakes—as under III, 7. Moderately numerous.
13. End-scrapers—as under III, 8. Rather scarce.
14. Side-scrapers or choppers, elongated and disshaped. Moderately numerous.
15. Blanks or roughly flaked but unfinished implements. Moderately numerous.
16. Spear points or knife-blades (mostly represented by fragments) of ordinary Neolithic form and finish, i. e., chipped in Solutrean style on both surfaces; more or less lanceolate, with straight, convex, or stemmed butt ends. Moderately numerous.
17. Arrow points of small, often delicate, sub-triangular outline, with straight, concave, convex, or stemmed butt ends. Rather scarce.

18. Potsherds, color gray to brick red; surface plain, string marked, incised, or stamped with geometric patterns, some laid on or modeled decorations. Moderately plentiful.
19. Hearths, with the usual accompaniments of ashes, broken stone, bone, etc."[1]

The quantity of later material which had washed down upon the floors of the valleys and was mixed with the flint implements eroding out of the lowest level, presented, at first sight, a most puzzling problem. It was only after careful study by Nelson, with assistance from almost every member of the Expedition staff, that the true situation was delineated. Doctor Loucks was indefatigable in searching hidden corners of the sand-dunes and the surrounding country. Chaney was almost as busy, and Shackelford during the intervals of photographing discovered flints in the most unlikely places.

The discussions at night about the camp-fire of tamarisk logs were extraordinarily interesting and stimulating. Stones of various kinds were baked in the fire to test their manner of breaking under the heat for comparison with those found in the ancient hearth sites. After the surrounding region had been thoroughly explored it became evident that nearly all of the material which the Dune Dwellers used for their artifacts and hearths had been brought there from some foreign locality. But where their source of supply had been located we were unable to discover until later in the season.

Since the story of Dune Dweller life in Mongolia was much more completely pictured by discoveries made during the season of 1928, I will reserve a fuller discussion of it for a later chapter.

A MONGOL CACHE

At the eastern end of the dunes, Loucks found a cave containing a Mongol's cache. A complete yurt, floor skins, clothing and household utensils had been neatly packed away, and the door blocked up with a stone. It was an excellent commentary on the owner's confidence in the honesty of his countrymen to leave such valuable material where it could easily be found by a traveler. I imagine, however, that the custom of the country made it quite safe, since I have frequently found similar deposits in other places.

BOTANICAL WORK

During my absence in Urga, Doctor Chaney had discovered few fossil plants. It became increasingly evident that during the Cretaceous this region had been too arid for the preservation of such material. Nevertheless, he kept his presses full of the living flora, which gave dozens of forms new to his col-

[1] *Op. cit.*, pp. 12–14.

lection. Plants of the pea family dominated all the rest, presumably because they are particularly adapted to arid conditions. Yet there was an abundance of geraniums, buttercups, anemones and many new grasses.

MAMMAL SKULLS FROM THE AGE OF REPTILES

One of the letters which I had brought from Urga for Walter Granger was from Dr. W. D. Matthew. Matthew was one of the least excitable men I have known but he was really stirred when he wrote that letter. He said that a tiny skull in a nodule of sandstone discovered in 1923 and labeled by Granger "an unidentified reptile" was, in reality, one of the oldest known mammals. It had been found in the Cretaceous Djadochta formation which yielded the *Protoceratops* and dinosaur eggs. In a hundred years of science only one skull of a mammal from the Age of Reptiles ever had been discovered. That single skull, named *Tritylodon*, from the Triassic of South Africa, is in the British Museum and was one of the world's greatest palæontological treasures. But it belongs to the group known as the *Multituberculata*, which died out in the Eocene, and had no very direct relationship to living mammals.

In his letter Doctor Matthew wrote: "Do your utmost to get some other skulls." Granger and I discussed it for half an hour, then he said: "Well, I guess that's an order. I'd better get busy." He walked out to the base of the Flaming Cliffs and an hour later was back with another mammal skull! It was a similar experience to that of Professor Osborn at Irdin Manha when he told me that he was going to find the tooth of a *Coryphodon* and two minutes later picked up the second one ever discovered in Asia. Such things do not sound possible, I will admit, but they did happen.

Granger's new skull was in a sandstone concretion but appeared to be well-preserved, as indeed it so proved. We had to leave for the west the next day, but when we returned in August, Granger and Olsen, "Buckshot" and Liu did some very intensive searching. It was close and trying work, for the skulls were in little nodules of sandstone that had broken out as the cliffs weathered away. There are literally millions of such concretions on the basin floor and it was simply a matter of examining as many as possible during the day. When one has inspected a thousand or more in the scorching sun with no result, the job loses its interest and becomes decidedly discouraging. Nevertheless, Granger and his assistants stuck at it day after day. At the end of a week they had a total of seven skulls. Moreover, all but one had associated lower jaws, and several concretions contained skeletal material. It was possibly the most valuable seven days of work in the whole history of palæontology up to date.

Those skulls were the most precious of all the remarkable specimens that we obtained in Mongolia. In the field, Granger carried them in his suitcase.

I took them to New York and they were hardly out of my sight on the long journey from Peking to New York. With a good deal of relief I presented them to Doctor Matthew at the American Museum on November 9, 1925. I told him that this was the direct result of his letter. He had asked for "the goods" and Granger and Olsen had "delivered" them. Within a few hours of my arrival at the Museum, Albert Thomson began the preparation of the skulls. It had to be done under a microscope and the hard rock particles picked off one by one with tiny needle-pointed instruments. It was such tense, nervous work that frequent rests were necessary. Still, by the beginning of the New Year, Thomson had finished the preparation and the skulls were ready for study by Drs. W. K. Gregory and G. G. Simpson, 1926.

From Shabarakh Usu we obtained eight partial skulls with associated portions of lower jaws, one skull without jaws, a fragment of a maxilla and part of a mandible; the remains of eleven individuals in all. These have been assigned to five genera and six species as follows:

Multituberculata
Ptilodontidæ
Djadochtatherium matthewi Simpson

Insectivora
Deltatheridiidæ
Deltatheridium pretrituberculare Gregory and Simpson
Deltatheroides cretacicus Gregory and Simpson
Hyotheridium dobsoni Gregory and Simpson
Zalambdalestidæ
Zalambdalestes lechei Gregory and Simpson
Zalambdalestes grangeri Simpson

SIGNIFICANCE OF THESE ARCHAIC MAMMAL SKULLS

Regarding these archaic mammals, Professor Osborn[1] has remarked:

"There is little doubt that the extinction of the large terrestrial and aquatic reptiles which survived to the very close of the Cretaceous prepared the way for the evolution of the mammals. Nature began afresh with the small unspecialized members of the warm-blooded quadrupedal class to slowly build up out of the mammal stock the great animals which were again to dominate land and sea. One of the most dramatic moments in the life history of the world is the destruction of the reptilian dynasties which occurred with apparent suddenness at the close of the Cretaceous, the very last chapter in the Age of Reptiles.

"We have no conception as to what world-wide *cause* occurred, whether

[1] Osborn, Henry Fairfield. 1910. "The Age of Mammals," pp. 97–98. Macmillan, New York.

there was a sudden or a gradual change of conditions at the close of the Cretaceous; we can only observe that the world-wide *effect* was the same: the giant reptiles both of sea and land disappeared."

Dr. W. K. Gregory, who with Dr. G. G. Simpson, 1926, studied the specimens which we collected, says that these first primitive mammals were tiny things hardly larger than a rat, with furry bodies and pointed snouts. They scampered about under the feet of the dinosaurs and may possibly have had some significance in the extinction of the reptiles by eating their eggs. Or it may have been that they were better adapted to withstand changes in temperature, or had superior brains and a better method of moving about. But at any rate their progeny eventually became the dominating creatures of the earth.

Doctor Gregory asserts that the skulls we found have proved to be veritable missing links in the story of mammalian evolution. They show that even at the close of the Age of Reptiles, mammals as a class had separated into marsupials and placentals, as well as an older side branch called multituberculates; also that the placental stock had already split up into various distinct families. "Hence it is not surprising," he writes, "that even in the five Cretaceous placental mammal skulls found in one locality in Mongolia we have representatives of four genera and two distinct families. The more insectivorous-like forms in some ways suggest the tenrecs or centeloid insectivores of Madagascar, but both their skull characters and their dentition are definitely less specialized than in their modern relatives. The members of the second family are distinctly more carnivorous in the general form of the skull and dentition and they combine characters of the carnivorous-insectivorous marsupials with others seen among the earliest creodonts or primitive placental carnivores of the Eocene Age of North America. In both families the braincase is distinctly smaller than in modern insectivores or marsupials of the same size.

"Huxley, Henry Fairfield Osborn and other palæontologists had already inferred that the remote ancestors of the higher or placental mammals in Cretaceous times were small forms of insectivorous-carnivorous habit, but prior to the Mongolian find the Cretaceous forerunners of the swarming placental mammals of early Eocene times were practically unknown except by a few scattered fragments from the Upper Cretaceous of North America of very doubtful affinities."[1]

Doctor Gregory further remarks that the Mongolian skulls confirm the above view of Huxley and Osborn and that they lend support to a prophesied early stage in the evolution of the famous "tritubercular" type of molar tooth.

[1] Gregory, William K. 1927. "Mongolian Mammals of the 'Age of Reptiles,'" *Scientific Monthly*, XXIV, pp. 225–231.

Doctor Simpson writes, in prefacing a discussion of these specimens:

"Not only are these remains by far the most complete ever discovered in the Mesozoic, but they also occupy a very strategic position in time and in space which makes close scrutiny of the relationships essential. In time they occur in the Cretaceous when, according to theories formed before their discovery and based largely on early Tertiary mammals, the differentiation of the placental orders should be in progress and not yet far advanced. In space they occur in central Asia in or near the region which a number of students, especially Osborn and Matthew, have considered as an important center of radiation, and probably the very one from whence came the groups of mammals which appear to have entered North America and Europe suddenly at the beginning of the Tertiary and which must have been undergoing an important deployment during upper Cretaceous time. The Mongolian Cretaceous insectivores are thus actual representatives so long hoped for but so little expected, of a group hitherto hypothetical and known only by its presumed descendants."[1]

In concluding his paper Doctor Simpson says: "The structure of the deltatheridiids agrees with their position in time between the pre-placental, pre-marsupial pantotheres and the close but distinct array of placental orders in the early Tertiary and with their position in space near the center of the land masses later dominated by placentals in suggesting that they, of all known mammals, stand closest to the common point of divergence of many or all placental mammals. In the skull and dentition they come very near to showing all the features which the most competent students of Palæocene and early Tertiary mammals have believed would characterize such a central group when found."[2]

[1] Simpson, George Gaylord. 1928. "Affinities of the Mongolian Cretaceous Insectivores," *Amer. Mus. Novitates*, No. 330, p. 1; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 85, pp. 1–11, 1930.

[2] *Op. cit.*, p. 9.

CHAPTER XXVI

TSAGAN NOR AND BAGA BOGDO

SHABARAKH USU TO TSAGAN NOR

DURING the time that Young and I were in Urga in 1925 the caravan had arrived at Shabarakh Usu, and left after depositing supplies of food and gasoline. Granger sent the camels on to Tsagan Nor, for they were traveling slowly. The long march of four hundred miles across an almost foodless desert had drawn heavily upon their slender reserve strength. If the soldiers had not detained them at the frontier, they would have been at Shabarakh Usu a month before us, rested and well-fed.

The men were only awaiting my return before starting for Tsagan Nor. We left June 8. Although expecting an easy trip we found much soft terrain in the valley bottoms. When we passed over it in 1922, it had been baked hard and easily supported the cars; now they broke through the thin crust in a dozen spots and we had hard digging and pushing. Still there were long stretches of good going and we could not complain. Twenty-three miles west of Shabarakh Usu we saw two wild asses. This location up to that time was the easternmost record for the species.

The caravan was camped at a tiny temple forty-five miles from the Flaming Cliffs. Several of the camels had died and the others badly needed rest and food. We left eighty cases of gasoline and all our specimens to await our return in care of the friendly lamas. Nelson reported great quantities of Dune Dweller artifacts along the trail and Chaney was enthusiastic over new plants.

Artsa Bogdo was deserted by the Mongols. All our friends were gone and not a yurt could be seen at the base of the mountains. We found the Mongols forty miles beyond, in the bottom of a beautiful valley watered by dozens of threadlike streamlets which twisted and turned across the meadow as they descended from the eastern end of Baga Bogdo. It was beautiful to look at but difficult for the cars to cross. We had to build dozens of turf bridges to negotiate the tiny streams. Our little lama hunter greatly longed to accept our invitation to accompany us westward, but he would first have to obtain

permission from the Buriat supervisor of the district, who was camped some miles away, and we had no time to wait. Our friends told us that they were very unhappy because so many restrictions had been put upon them by the Urga authorities that they were no longer a free people. They could not sell a sheep or goat without reporting all the facts; they were taxed exorbitantly and could not leave their circumscribed localities without permission. To the Mongols, who are as independent in nature as the eagle, such conditions must be almost insufferable.

TSAGAN NOR, A DISAPPOINTMENT

On June 10, 1925, we sighted Tsagan Nor. What a disappointment! The beautiful lake of which we had talked so much to our new men was only a quarter of the size it had been in 1922. Wide stretches of evil-smelling mud encircled the water; the brilliant green vegetation had given place to a margin of dull yellow grass. When the topographers arrived, Nelson looked at it disgustedly and remarked: "Tsagan Nor! It's little and it stinks!" Nevertheless, on the opposite side the beautiful yellow sand-dunes remained and the majestic peak of Baga Bogdo stood white and still in the brilliant sunlight.

We pitched the tents at the eastern end of the lake on one of the ancient shorelines which gave a fairly level shelf in the steeply sloping gravel bank. At our old camp site of 1922, the water was more than a quarter of a mile from the former beach. It soon became evident that bathing in the lake was not desirable. The mud was ankle-deep and as far as we could wade the water did not reach our knees. Three years ago it had been very slightly brackish; now it was strongly saline.

After our first disappointment had abated we began to enjoy the camp. It certainly is the most beautiful spot that I have seen in all Mongolia. The mountain with the vast alluvial fans sweeping out from the black canyons has an indescribable mystery and beauty. In the soft colors of sunset the lake is changed to green and blue, making a perfect mirror for the snow-crowned summit of Baga Bogdo and the yellow mass of sculptured sand-dunes. After dinner we usually sat in the twilight smoking and talking of the day's work. Sometimes I climbed to the edge of the gravel plain to sit alone in the desert stillness, to observe lake and camp spread below. The subdued murmurings of sleeping water-fowl or the faint long-drawn howl of a lone wolf only intensified the silence. One by one the candle glows in the tents would disappear and the camp become a vast, dim shape upon the white rim of the lake.

THE RISE AND FALL OF TSAGAN NOR

An old Mongol, who had lived all of his seventy-three years near the lake, told us that when we went there in 1922 the water was near its highest level.

PLATE LXXI.

ROM THE MOUTH OF TIGER CANYON, 1925. LOOKING SOUTH TOWARD THE MAIN PEAK OF BAGA BOGDO F

PLATE LXXII.

LOOKING NORTH FROM TIGER CANYON TOWARD TSAGAN NOR.

He said that forty and fifty years ago, Tsagan Nor was dry. He predicted that the water would disappear entirely that year, as indeed it did. There had not been sufficient rain to fill the little river, Tatsin Gol, which gave it life. The springs under the lake likewise had been cut off because the successive dry seasons, since our last visit, had lowered the level of the ground water.

Berkey and Morris decided that this was an excellent opportunity for a detailed study of a desert lake which would apply equally well, in generalities, to all those in this region. For this a map was essential, and Major Roberts with his assistants, Lieutenants Butler and Robinson, immediately set to work. The map was based on contour intervals of one and ten feet, the scale being one to twenty thousand. They found that the lake has an altitude of thirty-eight hundred and twenty-eight feet above sea-level. Seven beaches were apparent, the highest being thirty-three feet above the 1925 shoreline.

The lake itself offered additional evidence of recent climatic fluctuations. In 1922, when we saw it first, Tsagan Nor covered an area of nearly six square miles, but probably nowhere was the water more than ten feet deep even then. The geologists believed that the major outlines of the depression could have been formed most consistently by stream erosion in a former more humid period, but the minor depression occupied by the lake must have been made by wind action at a time when there was no water in the basin. Therefore, there certainly was an interval considerably more arid than at present. The seven ancient beaches, high above the water level of 1922, could have been made only by waves, and indicate that the water stood at those respective levels long enough to form the strand lines. Hence, it is obvious that there have been periods of greater humidity than in 1922 and 1925.

The geologists, Berkey and Morris, 1927, have remarked that: "If the lake were filled to the height indicated by the upper beaches, it would overflow at the east end and establish a stream which would follow a generally easterly course, marked out by a broad valley in that direction which doubtless was at one time the lake's outlet.

"The reason for emphasizing this point, however, is its bearing on changed climatic conditions. At the present time, and apparently for a long while in the past, there has not been enough water furnished to the Tsagan Nor basin to maintain a level of the lake high enough to overflow. In order to make the beach terraces, there must have been a time when water supply was more plentiful than now. This could happen only with a change toward greater humidity. Each of the well-marked beach levels must have been maintained for a long time. The changes that have taken place, therefore, have not been gradual or continuous, but they have come by steps or in cycles."[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, p. 392.

SUDDEN WEATHER CHANGES

June 10, the day we arrived at Tsagan Nor, was so hot that we sought the shade of tents and cars at every opportunity. The following morning heavy rain began at six o'clock, and a bitterly cold, east wind sent us into our fur coats. Such sudden changes of temperature come throughout the entire summer, and we have learned that it never is safe to leave camp for a day's trip without warm clothing, even during the hottest weather of July and August.

MOTION PICTURES OF WILD ASSES

When the various branches of work were well started at Tsagan Nor, Shackelford and I went out for motion pictures with the camera strapped in the tonneau of the car on its tripod. The hard, gravel plain north of the lake swarms with wild asses and antelopes. Seven miles from camp we stopped on the edge of a wide shallow depression. Even with the naked eye we could see hundreds of yellowish forms swimming in the desert mirage: wild asses, without a doubt, but never before had I seen a herd so vast. They were massed in three dense groups on the valley floor, and for miles the horizon was dotted with stragglers. By counting a block of two hundred we could estimate fairly accurately that there were at least a thousand animals in the herd. Subsequently, we learned that there were many more than that, for several hundred were below our sight in the bottom of a shallow ravine.

It was obvious that we must circle far to the east and drive the herd westward onto the gravel plain where for fifteen miles we had splendid going for the car. When we finally headed toward the asses, a group of forty surprised us before we reached the main herd. The animals began running rather slowly, stopping often to gaze curiously at the car. We did not press them, but maintained a steady pace of twenty miles an hour. The asses kept their distance ahead of us easily enough, and others began to come in from every side. The car drew them like a magnet. The yellow stream of asses converged on a course which brought them in front of us in a thundering mass. Hundreds were pounding along on both sides and we were enveloped in such a cloud of dust that I could barely see to drive. Photographs were impossible until we escaped from the dense herd of fleeing animals. I dropped back and swung to the outside of the largest group. There were perhaps three hundred asses so closely packed that they were running head to tail. As we shot forward beside the leaders, the herd swung like a troop of cavalry and tried to cross our front.

Shackelford, braced on the rear of the car, ground off film, swinging his camera from side to side as the mass divided. The fleetest individuals kept together, but the slower dropped behind, separated into groups of ten to

thirty, and took their own courses. But soon the small herds began to converge again and so the performance was repeated. By the time we had reached the western end of the plain which drops off steeply into the wide valley of the Tatsin Gol, asses were pouring over the rim like a cataract of yellow water.

When we turned back we encountered stragglers running about with their noses held high in the air, trying to find their companions. Yet they could not resist the fascination of the car; before we had gone a mile, more than a hundred were pounding along in front. Fifteen or twenty gazelles joined the parade, running with stiff black tails erect, sometimes springing into the air as if they were on pneumatic tires.

I let the herd cross our bow and swung away to the south. With the glasses we could see nine grazing quietly two miles away. We decided to try a new plan. Running a few yards, we stopped the car. The asses looked up, trotted toward us and stood with ears erect. Again they advanced and again. Before long they were less than two hundred yards away and Shackelford could work with the telephoto lens. This seems to be the only way to get pictures of the animals when they are not in rapid motion. It is impossible to stalk them on the plain for there is no cover. They do not often come to water-holes, as they seldom drink. One cannot successfully lie in wait for them anywhere, since they have the whole vast plain upon which to wander.

A *BALUCHITHERIUM* THAT DIED IN QUICKSAND

Shortly after our arrival at Tsagan Nor, Granger and Olsen transferred their camp about fifteen miles due north, at Loh, where we had found the *Baluchitherium* skull in 1922. We were exceedingly desirous of finding additional parts of this huge aberrant rhinoceros. In a great deposit of red sediments west of Loh, which we called the "Grand Canyon," Granger found the femur of a *Baluchitherium*, as well as hundreds of unidentifiable bone fragments, evidently a skeleton which had been destroyed by weathering. Great quantities of rodent jaws and teeth, carnivores and insectivores, and a few pieces of fossil wood, were also yielded by this same formation.

The credit for the most interesting discovery at Loh belongs to one of our Chinese collectors, Liu Hsi-ku. His sharp eyes caught the glint of a white bone in the red sediment on a steep hillside. He dug a little and then reported to Granger who completed the excavation. He was amazed to find the foot and lower leg of a *Baluchitherium*, STANDING UPRIGHT, just as if the animal had carelessly left it behind when he took another stride. Fossils are so seldom found in this position that Granger sat down to think out the why and wherefore. There was only one possible solution. Quicksand! It was the right hind limb that Liu had found; therefore, the right front leg must be farther

down the slope. He took the direction of the foot, measured off about nine feet and began to dig. Sure enough, there it was, a huge bone, like the trunk of a fossil tree, also standing erect. It was not difficult to find the two limbs of the other side, for what had happened was obvious. When all four legs were excavated, each one in its separate pit, the effect was extraordinary. I went up with Granger and sat down upon a hilltop to drift in fancy back to those far days when the tragedy had been enacted. To one who could read the language the story was plainly told by the great stumps. Probably the beast had come to drink from a pool of water covering the treacherous quicksand. Suddenly it began to sink. The position of the leg bones showed that it had settled slightly back upon its haunches, struggling desperately to free itself from the gripping sands. It must have sunk rapidly, struggling to the end, dying only when the choking sediment filled its throat and nose. If it had been partly buried and died of starvation, the body would have fallen on its side. If we could have found the entire skeleton standing erect, there in its tomb, it would have been a specimen for all the world to marvel at.

I said to Granger: "Walter, what do you mean by finding only the legs? Why don't you produce the rest?" "Don't blame me," he answered, "it is all your fault. If you had brought us here thirty-five thousand years earlier, before that hill weathered away, I would have had the whole skeleton for you!" True enough, we had missed our opportunity by just about that margin. As the entombing sediment was eroded away, the bones were worn off bit by bit and now lay scattered on the valley floor in a thousand useless fragments. There must have been great numbers of baluchitheres in Mongolia during Oligocene times, for we were finding bones and fragments wherever there were fossiliferous strata of that age.

"PAPER-SHALES" AT MOUNT USKUK

While Granger and Olsen were at Loh, the geologists and Doctor Chaney went northward twenty miles, to Mount Uskuk, where we had discovered a dinosaur skeleton and a deposit of paper-shales in 1922, in the Ondai Sair formation. More fish and insect fossils were obtained, and Chaney got some rather poorly preserved plants. They were mostly conifers related to, but unlike, those now living. Doctor Chaney remarks that the shales are thin-bedded and appear to have been deposited in lakes, on the shores of which grew the trees. Their leaves and stems were blown and washed into the lake and there mingled with the *Equisetum* and other rushes living in the water. The climate may be supposed to have been rather cool, with moderate or lower rainfall. If this had been a region of heavy rainfall, the variety and abundance of the fossil plant remains would have been much greater, as is the case with the Cretaceous floras in America and elsewhere.

ASCENT OF BAGA BOGDO

After the palæontologists and geologists had finished investigating the region north of Tsagan Nor, they transferred their operations across the lake to the slopes of Baga Bogdo. A little later, all the other men except Roberts, Young and I followed them. As far as we were aware, the snow-covered peak of Baga Bogdo never had been ascended by a white man. The Mongols themselves have a fear of the peak; they believe it to be inhabited by fierce beasts, and we were told that no one who attempted to ascend could return alive. Bleeding at the nose would begin and continue until the person died. For this reason it seems improbable that the natives have gone to the summit, although, as mountain-climbing goes, it is not difficult.

Doctor Loucks and Lieutenant Butler ascended Baga Bogdo on June 24. They left Tsagan Nor in the morning of the twenty-third and that night slept at the top of the alluvial fan, in the first gorge to the west of Tiger Canyon. The following morning was rainy and the entire mountain was enshrouded in a thick blanket of fog, but they left at six o'clock and reached the summit at one o'clock in the afternoon. The ascent out of the head of the canyon to a ridge which runs to the base of the peak was the most difficult. From the western side the mountain could be climbed much more easily.

They remained at the summit only fifteen minutes, for it was bitterly cold and the clouds enveloped them so closely that it was impossible to see more than a few yards. After planting the American flag and that of the New York Explorers' Club on the highest point, they built a cairn of rocks and left a letterhead of the Central Asiatic Expeditions in a bottle. They found no evidence of other men having been there; had any of the Mongols ascended the peak they would almost certainly have built an obo.

Baga Bogdo would doubtless prove to be an excellent shooting ground for sheep and ibex, as the animals are not hunted there by the Mongols. The natives assured us that tigers and leopards infested the mountain, but there are certainly none of the former within many hundreds of miles, and I never had authentic information of the latter in this region.

MORE FOSSILS FROM THE HUNG KUREH FORMATION

Some distance from the lowest slopes of the mountain the palæontologists investigated further the Pliocene deposit of gray clays which we had discovered in 1922 and named the Hung Kureh formation. I have already described its fauna in Chapter XIII, and their search did not greatly increase the list of species. Most interesting was the pelvis of a mastodon which measured sixty-four inches in diameter; also a great quantity of *Struthiolithus* shell fragments in a single deposit. Granger believes that this represented a nest of the gigantic

ostrich. In the same deposit, Chaney found numerous impressions of *Equisetum* and other swamp plants. Prior to the folding and uplift of the Altai, these plants grew on the border of a small lake. The beaver (*Castor*) substantiates such a view. The large deer certainly must have lived in a forest area, but the horse and ostrich were both adapted to the open plains. It is quite probable that during the Pliocene this was an open savanna country, with lakes and patches of forest interrupting the meadowland.

THE EXTINCT GIANT OSTRICH, *STRUTHIOLITHUS*

The ostrich must have been a very common and striking inhabitant, in late Pliocene and early Pleistocene times, not only of Mongolia but of all north and central China. Père Emil Licent and Père Teilhard de Chardin found, at their palæolithic site on the southern edge of the Ordos desert, that ostrich eggs had been an important article of food for the primitive humans. In the loess of China, *Struthiolithus* eggs are so frequently discovered that it is possible to buy them in many curio shops of Peking. The only known skeletal parts of the bird are a few toe bones which we found at Hung Kureh. Doctor Chaney had collected a hundred species of plants new to his collection at Baga Bogdo and brought back as a camp pet, the baby black vulture which I have described in Chapter XI.

STRUCTURE AND SURFACE FEATURES OF BAGA BOGDO

The geologists had an opportunity to study carefully the Baga Bogdo range which is about fifty miles long and not more than twelve miles wide. Baga Bogdo means "Lesser Buddha" as distinguished from Ikhe Bogdo, or "Greater Buddha," immediately to the west. The highest of the twin peaks of Baga Bogdo rises nearly eleven thousand feet above sea-level and about seven thousand feet above Tsagan Nor. It is one of a series of more or less isolated and recently uplifted mountain blocks which form the eastern extension of the great Altai system. Baga Bogdo is of the fault-block type of mountain which owes its relief to direct uplift or tilting. The geologists, Berkey and Morris, 1927, remark that "although the internal structure of the fault-blocks is as complex as the oldrock floor and includes folded rocks, the mountains themselves are not folded mountains. . . . The folding and the granite intrusions were accomplished long before the uplift of the present fault-block range began."

The northern face of the mountain is cut into a series of deep canyons fronted by enormous alluvial fans, some being ten miles or more in length and two or three thousand feet high. The fans are the result of stream action during periods of greater or less moisture and furnish much interesting evidence of climatic fluctuations.

TREES IN THE CANYONS OF THE ALTAI MOUNTAINS AND GOBI DESERT

In trenches which have been cut by river action through the alluvial fans during comparatively recent times, cottonwood trees have found sufficient moisture to maintain themselves. There is a considerable grove on the alluvial fan at the mouth of Tiger Canyon which represents a new species and has been described by Dr. Alfred Rehder, 1927, under the name *Populus pilosa*. The occurrence of trees in the desert parts of Mongolia is so infrequent and significant of climatic conditions that I am quoting in full Dr. Ralph W. Chaney's supplementary notes to Dr. Rehder's paper:

"The scarcity of trees in the Gobi desert region is striking evidence of the low rainfall over this great plateau. Elms, *Ulmus pumila*, are numerous on the grasslands bordering the Gobi to the south but have been noted in only a few cases extending northward for a short distance into the desert proper. A single willow tree, *Salix viminalis* var. *splendens*, was seen in one of the valleys at Ondai Sair. But apart from these, no trees have been noted on the Mongolian Plateau outside of the canyons of the Altai Mountains, a range which extends in a southeasterly direction across the western side of the Gobi desert.

"The comparative abundance of trees in the canyons of the Altai Mountains is the result of the great precipitation there, and the higher degree of protection from evaporation by the winds which are so characteristic of the Gobi proper. Not only are trees more abundant, but plants of all sorts are more numerous and, as observed during the summer of 1925, continue in a green state long after the vegetation of the adjacent lower country has become dry. We experienced rain on three of the six days spent on Baga Bogdo during the latter part of June, and there was a considerable fall of snow on the peak on June 20th; a month later at Artsa Bogdo there were showers on four of the five days we spent in the mountains. Several of the higher peaks, such as Baga Bogdo and Ikhe Bogdo, have snow on their tops and protected slopes during most or all of the year. This was the case in 1925, and there was ample evidence to indicate that snow had persisted for at least two years in some of the larger canyons. As a result there are permanent streams in these canyons, along which conditions for plant growth are in striking contrast to those of the arid open slopes beyond the canyon mouths. None of the streams were observed to flow beyond the mouths of their canyons before they disappeared by evaporation and by sinking into the coarse gravel and sand of the fans. It was in these canyons and in the upper portions of the fans below their mouths that *Populus pilosa* was collected and observed on Baga Bogdo and Ikhe Bogdo. None were seen on Artsa Bogdo and Gurban Saikhan, the easternmost mountains of the Altai which extend farther out into the Gobi and may be supposed to present less favorable conditions for tree growth. The occurrence in one of the larger canyons on the north side of Baga Bogdo, called Tiger Canyon by members of

the Expedition, will here be described as typical of the several similar occurrences on this mountain and on Ikhe Bogdo to the west.

"Tiger Canyon in its lower portion is cut into a coarse alluvial deposit, the walls rising steeply some 400 feet to an upper terrace; its width is 2000 feet at the top and a few hundred feet at the bottom. A quarter of a mile above the mouth the canyon is cut into granite and is greatly narrowed with much higher walls. A mile and a half above the mouth metamorphic rocks form a still narrower canyon. The floor is littered with coarse gravel and with boulders up to 20 feet in diameter, and there are numerous terraces which give it an irregular surface. The stream was at most only a few feet in width and less than a foot deep as observed in June, 1925. It has a high gradient and the water is clear and cold. Extending for several miles down the side of the mountain below the mouth of the canyon is a broad alluvial fan, cut by numerous dry channels, and littered with gravel and coarse boulders. The stream disappears into the gravel more than a quarter of a mile above the canyon mouth, but its presence in the gravels under the surface of the fan may be inferred from the distribution of trees for more than a mile down the steep slope of the fan below the mouth of the canyon. These trees, all of which are cottonwoods, *Populus pilosa*, are from 15 to 25 feet in height and from 8 to 18 inches in diameter. At the lower end of their distribution (elevation 5,200 feet) many are dead, indicating that the supply of water there is inadequate. Except for the trees the fan is essentially bare of vegetation, but along its borders a species of *Artemisia*, as yet undetermined, is abundant, together with several species of grass and legumes, and low bushes of *Prunus mongolica*.

"In the canyon the trees are more numerous and larger, reaching a maximum height of about 40 feet and a diameter up to 30 inches. Here the added protection of the canyon walls permits a more symmetrical growth of the trees. They are found along the stream for a distance of at least two miles up the canyon to an elevation of about 7,500 feet where it becomes too rocky and narrow for them to gain a footing. Since most of the specific determinations of the flora have not yet been made, a complete and exact list of the associated plants cannot here be given, but it includes *Salix phylicifolia* which reaches the dimensions of a small tree, *Salix glauca*, *Cotoneaster melanocarpa*, *Lonicera microphylla*, and *Spiræa chamædryfolia* among the woody plants, the fern *Cystopteris fragilis*, and numerous herbs of which the Leguminosæ and Ranunculaceæ are well represented. No weedlings of *Populus pilosa* were observed in Tiger Canyon or on its fan, but there were a few in the next large canyon to the west where there is also a permanent stream. While trees here are numerous, few of them reach the size of those in Tiger Canyon, the average diameter being little more than eight inches. No exact count of the trees was made, but it may be conservatively estimated at several hundred in each of these

PLATE LXXIII.

A. COLLECTING FISH FROM TSAGAN NOR, 1922.

B. ANDREWS IN THE MESS TENT AT KHOLOBOLCHI NOR, 1925.

PLATE LXXIV.

B. SO-CALLED TAMARISK TREE.

The base has already been partly buried by drifting sand

two canyons. In the only large canyon observed at Ikhe Bogdo, the next large range west of Baga Bogdo, the trees were not as numerous and did not extend as far down the fan.

"The use of the wood of *Populus pilosa* by the Mongols is abundantly indicated by sawed stumps in Tiger Canyon. Portions of the logs are hollowed out and made into tea mortars and water containers. The Mongol name for this tree, 'Tore,' meaning hollow, is indicative of this utilization of it by a people whose nearest approach to contact with forests is in the scattered groves of the Altai canyons.

"In addition to *Populus pilosa* and two species of *Salix*, which were the only trees seen by the writer in the Gobi region proper, an arborescent species of *Betula* was seen by Charles P. Berkey in a large canyon on Ikhe Bogdo. It is significant to note that all three of these genera, as well as *Ulmus* of the grasslands and Gobi border of the south, have windborne seeds, a fact which is probably responsible in large part for their distribution in the more suitable areas of the arid plateau of Mongolia. The source of the seeds which first established the trees of the Altai canyons may be supposed to be the higher and moister continuation of the range to the west. An alternative explanation may be that these patches of trees represent relict areas of a forest which was once more widespread and probably continuous with that farther west along the Altai Mountains. The finding by Nels C. Nelson of birch-bark utensils in a prehistoric burial north of Ikhe Bogdo is evidence, in any case, of the presence of *Betula* in the region for several hundred years.

"No data are available as to the age of the trees of *Populus pilosa*, but in view of their probable slow growth it may be supposed to reach several scores of years in the case of the larger individuals. Bearing on this problem is the situation of several of the trees near the head of the fan at Tiger Canyon. The basal 8 or 10 feet of their trunks has been buried by gravel deposits, which may be interpreted as indicating a fluctuation of rainfall and therefore of deposition during the period in which they have been living."[1]

PRE-MONGOL GRAVES NEAR BAGA BOGDO

At the base of Baga Bogdo there were a number of circular mounds enclosed by stones which Nelson believed to represent graves. He opened half a dozen without finding anything of importance. At last he obtained a fairly well-preserved human skeleton but no implements. These graves doubtless represent a pre-Mongol people of the Bronze and Iron Ages.

[1] Rehder, Alfred. 1927. "A New Poplar (*Populus pilosa*) from the Eastern Altai Mountains." With Supplemental Notes on the Distribution and Habitat. By R. W. Chaney. *Amer. Mus. Novitates*, No. 292, Nov. 30, pp. 3–8; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 79, pp. 1–8, 1930.

CHAPTER XXVII

KHOLOBOLCHI NOR

EXPLORING THE OROK NOR DISTRICT

FROM Tsagan Nor we could see the mountain Ikhe Bogdo bulking hugely against the western sky. We knew that there was a large lake, called Orok Nor, at its base, but none of us had seen it. As we expected to continue westward as soon as our study of the Tsagan Nor region was ended, Loucks, Young, Shackelford and I went out to explore the district.

We found that the hard gravel plain extends for thirty miles as an unbroken floor except where it is cut by the Tatsin Gol which flows into Tsagan Nor from the north. The bordering plain extends southward to the eastern end of Orok Nor and leads to an old beach, raised high above the water level, forming a wide semicircle six or eight miles long and at least two hundred feet wide. It formed a splendid gravel speedway on which the car could run at fifty miles an hour. The beach ended abruptly in a vast sand-dune area which encircled the lake except on the southern side, where the water lay close to the base of the mountain.

We got the car through the dunes to the water at the eastern end after a hard struggle and much pushing, but reached only a series of reedy lagoons and not the main lake. The inlets swarmed with birds; eared grebes, coots, ducks of half a dozen species, geese, herons, storks, gulls, terns, and many shore-birds were breeding there. I had never seen such a concentration of avian life anywhere else in Mongolia.

It was evident that the lake was many miles in length and very wide. Some hundreds of years earlier it must have been of vast extent—a veritable inland sea. The area now covered with yellow sand-dunes must have been under water in quite recent times. At least two large rivers flow into it from the north, although they contained little water at the time of our visit.

After spending the entire day in a fruitless endeavor to find a way for the cars to the main shore, we camped at sunset where one of the rivers breaks through the hills on its way to the lake, nine miles away. Our sleeping-bags

were spread on a grass-covered shelf beside the river, just under the brow of a rocky cliff. At dusk, bats of two species darted in and out among the rocks, and we did our best to collect a few specimens, but as they appeared for only the fraction of a second against the sky it was like shooting at a phantom.

DISCOVERY OF THE KHOLOBOLCHI NOR

After another unsuccessful attempt to reach the lake next morning, we turned north and climbed in the car to the summit of an exceedingly rough range of mountains, from which we could look back and see the western end of Ikhe Bogdo. We thought that we could pass quickly across the mountain summits to the northern face. To our great surprise the range was eight miles across. Each summit was connected by ridges just wide enough for the car to pass. Expecting to reach the other side at any moment, we kept on until we were deep in the maze of peaks. It was a strange place for a motor car! We were about two thousand feet above the level of the plain, surrounded by rugged crags. Because of Young's skilful driving we eventually reached the northern face of the mountain, emerging by way of a narrow rocky canyon.

In the distance we could see gray and red bluffs and isolated buttes in half a dozen places, but the enormous basin in which they lay was deep in loose sand and spotted with "nigger-heads." We reached several of the exposures after hard work, and although few bones were to be found, they evidently contained some fossils—certainly enough to warrant more careful investigation in the future.

At last we came to what we eventually learned was the old Uliassutai caravan trail which passes north of Tsagan Nor, and followed it eastward. We were glad to be on passably decent terrain again. Thirty-eight miles before we reached Tsagan Nor the trail led us into a low marshy bottom from which we could see two lakes some distance to the north. By retiring to the high ground and making a wide circle, we reached the farther and smaller lake, which was evidently rapidly drying up. The mud of its shores gave forth such a strong odor of carbon bisulphide that it was nauseating. It had even driven away from the green grass of its shores the several herds of sheep and goats which were grazing in the valley.

While we were on our way to this lake, a violent storm arose. The wind blew from the north with such velocity that it was almost impossible to force the car against it. At last it became so strong that the car could do no better than three or four miles an hour even with the engine running at full speed. We turned back just as a terrific deluge of rain began; in five minutes we were shivering even though our rubber coats kept us fairly dry.

The larger lake, which we learned was named Kholobolchi Nor, proved to be a charming place. To the west the gravel plain dropped abruptly down

to the lake hollow where a beautiful green lawn spread right to the water's edge. It would make an excellent spot for a base camp from which to investigate the surrounding region. Returning to the trail we continued eastward toward Tsagan Nor. After going only six miles the trail descended to a wide basin filled with huge "nigger-heads." At the western edge a clear spring ran out of a low rounded bluff of gray clays. After a few moments' search we discovered a few bits of fossil bone, but did not remain to make a thorough search.

CAMP AT KHOLOBOLCHI NOR

The Expedition moved to Kholobolchi Nor June 28. Tents were pitched on a strip of turf as green as emerald. Mine was not more than two feet from the water's edge, at a point where it cut under a low bank. Immediately in front of the door we dug a well, or rather two wells. Shackelford and I were sponsors for one; Olsen and Loucks for the other. Each of us sank a gasoline box in the pit and surrounded it with white stones. The water was clear and sweet, for the entire grassy terrace was underlaid with springs, the water being rather too close to the surface.

Nineteen white swans were floating quietly near shore when we drove in and moved only a few hundred yards down the lake when our tents were pitched. A great black and white stork, *Ciconia nigra*, with red legs and beak, stepped majestically along the water's edge; gulls and black-capped terns fished energetically, and dozens of sheldrakes trailed their tiny broods behind them like waving streamers.

On the desert we had seen one or two brown vipers, *Agkistrodon*, but near the lake I caught a new snake, *Coluber spinalis*, which Clifford Pope, 1929, records also from Shantung, Chihli and Shansi provinces, China.

After tiffin the entire camp went in for a swim. The bottom is fine sand in most places, but one must wade out for two hundred yards before the water reaches one's shoulders. To the west and south, sand-dunes, which are an invariable accompaniment of all Gobi Desert lakes, lie in yellow waves. Three or four Mongol yurts were pitched just at their edge. That night we were treated to a glorious sunset; as we watched the gorgeous display, meanwhile listening to the victrola, all of us agreed that an explorer's life is not so bad.

OLIGOCENE AND PLEISTOCENE FOSSILS

On the way to Kholobolchi Nor, Berkey and Morris discovered a few fossils in the gray clays six miles from the lake which I had "marked down" on our first visit. Mastodon and horse, *Equus*, could be readily identified, indicating that it was a Pleistocene deposit. The next day the palæontologists prospected the exposure more thoroughly and discovered some good

specimens of teeth and jaws, confirming the view that the deposit was of Pleistocene age. We were particularly glad to find such late sediments, for they had been absent in the region we had explored previously. The Pleistocene appears to have been a period of erosion rather than of deposition in the central and western Gobi.

Not far from the Pleistocene bluff, near Kholobolchi Nor, Doctor Berkey discovered a thin patch of Eocene sediments in which Buckshot found the skull of an Amblypod, probably related to *Eudinoceras*. Olsen discovered a second skull which appears to represent a different species. Except for the two teeth obtained in 1923 by Professor Osborn and myself at Irdin Manha, this American group was unknown in Asia. Although the two teeth were unmistakable and definitely placed the great group of amblypods as former inhabitants of Asia, these skulls will tell a more complete story of their relationships to the American forms.

Granger went many miles in the car, investigating every likely-looking spot in the huge basin. As a whole, the Pleistocene deposits and exposures of Oligocene age north of the lake proved rather disappointing, for the fossil content was neither rich nor varied. Still, what we did obtain was of the highest importance.

DUNE DWELLERS AND OTHER FORMER INHABITANTS

Nelson found more of the Dune Dweller culture in the "tamarisks" of the basin just in front of the Pleistocene exposure. Also we were thrown into a fever of excitement by Nelson's discovery of a human skeleton in the bluff itself one evening just at dusk. Further excavation proved it to be a burial, much to our disappointment. Some of the bones were wrapped in birch bark and pieces of wood had been used to roof the grave. Without question it was pre-Mongol and more than a thousand years old, but we had hoped for a skeleton of Pleistocene man. Subsequently, Nelson found a considerable exposure of the Shabarakh formation near Orok Nor, lower than the ancient beach levels. Thus the water had covered that formation for a long time *after* the Dune Dwellers had vanished. This bears out the geologists' conclusions that the culture is many thousands of years old.

On the gravel plain east of camp, Nelson found several artifacts which could safely be identified as of late palæolithic technique. They included choppers or large scrapers and oblong flakes of Mousterian type, as well as double-end scrapers of Aurignacian workmanship. Although none were actually found embedded in the Pleistocene plain, nevertheless there was strong reason to believe that the artifacts belonged there and had weathered out of the strata. The area has been undergoing erosion probably ever since mid-Pleistocene time.

On the same surface and in a number of other localities, especially in the region between Tsagan Nor and Orok Nor, there are thousands of fractured boulders and pebbles more or less weathered but showing successive stages of flaking. As Mr. Nelson says: "A large number of these splintered pieces assume artificial form and character, even to the extent of now and then showing the bulb of percussion. In addition, nearly all of them exhibit more or less retouched margins, a succession of chips having been removed much after the manner of true Mousterian technique. Yet the obviously varying ages of the chip beds leave no doubt that the specimens are the veritable product of natural forces still at work."[1]

I must state that Mr. Nelson takes very little stock in eoliths as a whole and those of Mongolia in particular. After walking for some miles behind our caravan, when it was passing over a plain strewn with jasper rocks and large pebbles, he came to the conclusion that a camel with its feet could make just as good eoliths as could primitive man with his hands. Rocks were broken and flaked by the weight of these heavy animals in a way which imitated most remarkably the eolithic technique. I believe I am correct in stating that, after his experiences in Mongolia, Mr. Nelson would regard suspiciously the finest eolith that ever has been discovered.

Nevertheless, much remains to be elucidated regarding the true and false artifacts of the Orok Nor region. It certainly is the most important locality, from the standpoint of a very primitive culture, that we discovered in Mongolia. There is great probability that humans using the Mousterian technique lived during the Pleistocene in this locality. Prolonged search might produce much more evidence of their habitation. In a region such as this, where there is no hope of finding caves or rock shelters, archæological work is exceedingly difficult. Our greatest hope of discovering human fossils lay in river drift or bog deposits. The fact that the Jesuit Fathers, Teilhard and Licent, found a great deposit of Mousterian implements in the Ordos desert, just south of this region, is most important. Their discovery could be definitely dated by accompanying animal bones, and Nelson believes that his Mousterian-type implements represent the same culture.

The deposit found by the Jesuits was on the shore of an ancient lake, long since "drowned" by drifting sand. It is probable that in Asia Neanderthal man, or his contemporary, was a lake-shore dweller. Doubtless he sought the protection of a bank, or he may have built himself a shelter of branches roofed with skins. There must have been just as few caves and rock shelters in his time as there are at present.

[1] Berkey, Charles P., and Nelson, N. C. 1926. "Geology and Prehistoric Archæology of the Gobi Desert," *Amer. Mus. Novitates*, No. 222, June 28, p. 11; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 67, pp. 1–16, 1930.

WATER-FOWL AND LAKE PLANTS AT OROK NOR

Two days after our arrival at Kholobolchi Nor, Chaney, Shackelford and Loucks went to one of the lagoons of Orok Nor to photograph and botanize. They found hundreds of water-fowl breeding on the islands of tule grass, but they were about two weeks late for nests. Much to their surprise, a great flock of white spoonbills frequented the lake. This was the first time we had encountered them anywhere in Mongolia.

Chaney obtained a splendid collection of plants. He found that the flora is much like that of our American lakes, including water buttercups, bladderwort, pond weed, green algæ, cattails, tule and duck weed. Strangely enough the arrow leaf, pickerel seed, bulrushes and several others of the American lake flora are absent.

GLACIAL CIRQUES ON IKHE BOGDO

The geologists made an arduous but profitable trip to Ikhe Bogdo, spending several days on the mountain. Their principal object was to investigate the glacial cirques which could be seen in the heads of all the major valleys and which record the easternmost glaciation in the Altai system. The geologists have said that, except for the cirques found in several mountain ranges, the Ice Age in Mongolia is the most difficult period to read, because of the lack of recognizable deposits. Nevertheless, it is evident that the climate of the Pleistocene was more variable than any post-Cretaceous period; that it included epochs warmer than the present and epochs in which the higher mountains bore large alpine glaciers, while parts of the Siberian coastal slopes were covered by broad ice-caps. But the Gobi region itself was not glaciated, the ice being confined to the actual mountain valleys. The valleys suggest that the Pleistocene in Mongolia was largely a period of erosion, for it is evident that an enormous amount of material was removed from the country in geologically recent times.

PROBLEM OF THE LOESS DEPOSITS

Berkey and Morris, 1927, also remark that the "peculiarly characteristic Pleistocene deposit called loess seems to be lacking in Mongolia. In our explorations we saw little or none, and we find no reports of it in the literature except from the extreme southern margin of the Gobi. The loess of China, south of the Gobi, may well have been blown from Mongolia and from the basin of Lop Nor, especially if the mountain barriers that now separate these lands from China were lower during part of Pleistocene time than they are now."[1]

[1] Berkey, Charles P., and Morris, Frederick K. 1927. "Geology of Mongolia," *Natural History of Central Asia*, Amer. Mus. Nat. Hist., II, p. 385.

The problem of the origin, climatic conditions and age of the loess in China is one about which there has been much discussion. It is a fine-grained loam formation which is by no means restricted to China but is found in various parts of the Northern Hemisphere. The term "loess" was applied to it in the German Rhineland. It is a soil of high fertility which covers a large part of north China in some places to a depth of two hundred feet.

Barbour remarks that "the true Chinese loess is a yellow-grey, poorly-consolidated loam deposit of the fineness of silt, which shows a characteristic absence of horizontal layer structure, being essentially non-stratified and showing a tendency to split along roughly vertical joint-planes so as to form perpendicular cliffs and walls."[1]

There are very strong reasons to believe that wind has been the principal agent in the formation of loess. It contains few fossils, but Dr. J. G. Andersson has recorded finds of rhinoceros, sheep, hyena, bear, beaver, horse and deer. The eggs of the giant ostrich *Struthiolithus* are frequently discovered in the loess of China. It is quite probable that these were covered with a wind-drift deposit and thus prevented from hatching, as undoubtedly happened in the case of the dinosaur eggs of Shabarakh Usu. It is a current remark in Peking that the disagreeable storms which affect all north China in the spring bring "dust from the Gobi Desert." We have already seen that there is little, if any, loess in the Gobi; the sand and gravel are too heavy to be carried for any considerable distance. As a matter of fact, most of the storms of Peking sweep up local dust from the streets and the immediate surroundings of the city. The instances when yellow clouds floating hundreds of feet in the air cover vast areas of north China are comparatively rare. During those storms a fine yellow silt sifts through the cracks of doors and windows and into the tightest boxes. This is obviously loess which probably comes from Chihli, Shansi, Shensi, and other north China provinces. These storms are quite unlike those that we have in the Gobi.

THE LAND BEYOND THE ALTAI

While work went on at Kholobolchi Nor, my thoughts were busy with the future. I was anxious to see what lay beyond the Altai Mountains. Day after day I had gazed at the massive ramparts barring us from the south. The natives related tales of wild camels and of the famed Prjevalski horse; they told us of barren gravel deserts, of sand and mountains, of death from thirst. But each tale only strengthened that restless urge which every explorer knows—the desire to go and see. The mountains lay there like a silent challenge. We knew that we could cross them on ponies, but could we cross

[1] Barbour, George B. 1925. "The Loess of China," *China Journ. Sci. and Arts*, III, No. 8, pp. 454–463, and No. 9, pp. 509–519.

with a motor car? We should never know until we tried. Kozloff, the famous Russian explorer, told me that he had crossed the Altai near this spot, but he had a caravan of camels. We thought that we had located the pass he used, for we could see a sharp break in the peaks just west of Ikhe Bogdo. On July 1, Roberts, Young, Lovell and I left camp in an automobile with my faithful Mongol, Tserin. We carried an assortment of spare parts, food for a week and gas to run five hundred miles. Granger knew the general direction we intended to take and that our objective was to get through the mountains some way; if we did not return he could trail us in another car.

A MIRAGE THAT WAS MAPPED

After running a few miles westward we headed directly south toward the mountains. Roberts, by taking compass directions, was roughly mapping our route. From the summit of a low rise we saw a small lake about two miles to the west. Gulls and terns were flying over the mirror-like surface and islets of tule grass stretched a long green finger toward the center. From our elevation Roberts sketched the shoreline while I studied it through my powerful binoculars. Slowly it began to dawn upon me that something was wrong about that lake. The beach grew indistinct and the tule grass islands danced about in a most peculiar way. Roberts and Tserin both noticed it, too.

"Bob, I think we had better run over there before you go any further with that sketch," said I, and started the engine. In five minutes we were on the "shore" of the "lake"—only there wasn't any shore and there wasn't any lake. It was the most perfect mirage we had ever seen. Not even a suggestion of water or of the tule grass islands, and our "gulls" were sand-grouse. Yet from first sight, all of us would have staked our lives that it was real. It is an axiom of Arctic exploration that you never can be certain that land *is land* until you have put your foot upon it. Cloud banks lying over the ice make perfect mountains and coast lines. It is an axiom of desert exploration that a lake never *is* a lake until you have waded into its waters.

"KOZLOFF PASS"

The mirage served a useful purpose, for during our investigations we had crossed a well-marked trail which led toward the foothills between us and the mountains' base. It took us up a dry stream-bed, across a grassy ridge and into another wash. In some places the gorge was wide with bare rocky slopes; in others the stream had cut a narrow canyon, and sheer walls towered above us five hundred feet or more; sometimes great rock slides threatened to bar our way, but always there was a gate through which the car could slip.

We emerged into a beautiful valley on the north side of the majestic ramparts of Ikhe Bogdo, the Great Buddha, its snow-covered peak rising

into the clouds. Our trail led up a vast alluvial fan ten miles long, toward a deep cleft in the mountain wall. I realized that it must be a river gorge and probably would be choked with boulders. The fan gave promise of what was to come. A chaotic mass of rocks paved the surface, and it seemed madness to drive a car into the debris. Still, Young and Lowell did pilot it safely for ten miles actually into the canyon's mouth. There we stopped and continued on foot. From the summit of a thousand-foot cone we could see how the gorge wound in and out among the peaks, passable for horses or camels without a doubt but hopeless for cars. We named it "Kozloff Pass," as it is almost certainly the one the great Russian explorer discovered.

"DESERTED VALLEY"

At the western end of the beautiful valley north of Ikhe Bogdo the horizon dropped to a level ridge where the mountain chain seemed to break. It appeared to be not more than ten or fifteen miles at most, but we ploughed forty miles through the sand before the crest was reached. Then we discovered that the range bent sharply to the south and that higher and rougher peaks lay beyond. There was not a sign of human life, but a dry lake-bed ran the entire length of the valley, which swarmed with antelope and wild asses. They were feeding on alfalfa, and we found this plant growing wild at half a dozen spots in other parts of the Gobi. I never have seen such a concentration of game in a small area. Antelopes were running beside the car and crossing our course every moment; tiny fawns hardly larger than rabbits jumped out from almost under the wheels, where they had been lying flat on the ground with necks outstretched.

Herd after herd of wild asses pounded along beside us, unable to tear themselves away from the fascination of the car. Most of the asses were mares and many of them were chaperoning fuzzy, long-legged colts. It was amusing to see the little fellows bend to the work of keeping up with their mothers. With ears laid back and slim legs flying they put every ounce of strength and determination into what probably was the first time in their short lives that they had run from danger. Once we saw four wild asses fighting. Kicking and biting viciously, they kept at it until the car approached and they joined the zoölogical assemblage which we were driving up the dry lake-bed.

In spite of the thousands of animals, there was something utterly desolate about the valley. Perhaps it was the black mountain walls which shut us in and the fact that for more than a hundred miles we had not seen even the remains of an old camp-fire or the circular mark left by a Mongol tent. All of us were exhausted when we camped at dark in a sandy stream-bed. The speedometer of the car registered one hundred and fifty miles, and in

that entire distance not a well or stream had we seen. There was a gallon of water left in one of the bags which would do for drinking and coffee, but we did not worry, for in the old lake-bed half a dozen patches of vivid green grass indicated that water could not be far below the surface. During our night in "Deserted Valley" it rained heavily. We had no tents, but, pulling the flaps of the canvas sleeping-bag covers over our heads, we remained perfectly dry; moreover, there was the comforting assurance of sufficient water in the morning.

The day began with hard work. When crossing a dry stream-bed the car suddenly sunk to the hubs in moist sand and there it remained for four hours. Experience has taught us to take such things philosophically. With hardly a word everyone began to unload and to collect stones. To build a rock foundation under the wheels is the only possible way to get out of such a predicament. The quicksand appeared to be bottomless and the stone base was six feet deep before it would hold the jack and the weight of the car.

Across the valley there was, in the ragged line of peaks, a dip which suggested a pass. None of us had much hope that it would be possible to get through, but it was the only chance. Crossing the low foothills successfully, we started up the slope only to emerge from behind a rocky corner on the very brink of a stupendous chasm. Red granite ridges capped with dull black lava cut into a thousand fantastic shapes showed against a lowering sky. In the utter stillness it lay like a red inferno. While Roberts took the compass points for his map, the rest of us explored the nearest canyon, which divided into a labyrinth of passages and roofless corridors. I suppose that some day when a railroad parallels "Deserted Valley," tourists will picnic in the gorge. Of course, they will name it "Dante's Hole"!

ON THE SOUTHERN SIDE OF IKHE BOGDO

A long detour took us around the chasm and the break in the saw-tooth horizon proved to be a pass indeed. A hard floor of gravel led gradually toward the summit between slanting peaks. It was only seven thousand feet high, but it seemed as though we were mounting toward the roof of the world. As the car swept upward we sang and laughed, our spirits soaring with every foot.

From the crest, a vast panorama of low ridges spread out before us like the waves of a great sea in a heavy gale. We could look far into the mysterious region south of the mountains which for us at the moment was the "Land of Heart's Desire." But we soon found that its interest lay chiefly in anticipation. It was beautiful but commonplace. Great plains sloped gently downward and the car flew like a bird over the gravel surface. Not a sign

did we see of the reported fossil "badlands" or the terrible desert of thirst and death; only line after line of pink-white ridges of quartz and marble.

THE GREAT MONGOLIAN ROAD TO TURKESTAN

We crossed a well-marked trail running east and west. Although on none of the so-called maps was there an indication of a caravan route, we discovered later that it was what caravan men call the Great Mongolian Road to Chinese Turkestan. We swung east on the trail and found splendid going. The great flat pads of a camel's feet are natural road-makers, tramping the sand until it is as hard as rock. In spite of the Mongol reports of the lack of water, the trail led us to a magnificent spring and just beyond it we saw the blue tent of a great caravan. They were Chinese from Shansi Province. As I know that dialect and we were all wanderers in the desert, they greeted us like old friends. In the big tent we drank tea and ate boiled millet. Twenty men with two hundred camels, they were on the way to Kobdo near the northwestern frontier of Mongolia. It was early May when they left China and they would not arrive in Kobdo until January, 1926. Nine months of the same life day in and day out, making and breaking camp, eating and sleeping. Nothing to interrupt the dreary monotony except the winter's fight against snow and cold and perhaps a bandit raid.

Tea, cloth and tobacco were their goods to barter for camel's and sheep's wool, hides, furs and ponies. The same trade in the same way over the same trails has gone on for untold centuries and will continue until that not far distant day when a railroad connects China with central Asia. Then at one blow the romance and glamour of the desert will be destroyed. Tourists will sit in heated cars, eating the food of Europe, reading week-old newspapers, and comprehending not at all the glorious history, the tragedy and the romance of the Gobi trails.

WILD CAMELS OF THE BLACK GOBI

The Chinese could give us no late news, but we learned much about the country, for they had made this journey four years earlier. The wild camels, they said, were far to the southwest, just west of the Etsin Gol in the Black Gobi; the trail we were on eventually broke through the Altai Mountains and swung north to Uliassutai and Kobdo; for several hundred miles both east and west the country was a gravel plain. Three of the men said that they had seen wild camels in the Black Gobi but only at a distance. They were very shy and almost like mythical creatures. Some Mongols, they said, had caught them when young but that even then they were difficult to tame. As far as I can discover, very little has been published about wild camels. Doubtless this is due to the fact that few explorers have visited the arid Black Gobi where they live.

RECONNAISSANCE ALONG THE GREAT MONGOLIAN ROAD

Continuing eastward on the trail, we camped on the banks of a small but swift stream called the Tsagan Gol (White River) which runs southward from the foothills between Ikhe and Baga Bogdo. In 1926, when I went to London to lecture before the Royal Geographic Society, I examined, with Sir Francis Younghusband, the route maps he made of his famous journey from Peking to India in 1887. We found that he, too, had camped at this very spot. Strangely enough, my thoughts were full of this gallant explorer on that evening. I knew that we must be near the route which he followed, and I told my companions much about this trip which he had made when only twenty-four years old. We had a delicious dinner of antelope steaks cut from a young buck I had shot the day before; then we lay in our sleeping-bags smoking and looking up at the stars until nearly midnight.

A few Mongol yurts were pitched near the river, and an old native told us that another large caravan trail paralleled the one we were on, to the south. He also said that he had seen both wild camels and saiga antelopes about two hundred miles to the southwest in sandy country. This, I think, was a mistake, at least as far as the saiga are concerned. The trail of which the old Mongol spoke we found ten miles south of the one we were on. At that point it ran almost east and west. Doubtless it eventually swings southward to Hami, after it has avoided the sand-dune area which it encircles.

POOR COUNTRY FOR FOSSIL-HUNTING

The country was unsatisfactory from our standpoint. It was an extremely arid desert. Except in a low basin near a small lake, called Nagan Nor, and at Tsagan Gol, we saw no Mongols. There was not sufficient vegetation on the hard gravel plain to support a herd of camels. Perhaps a dozen gazelles and two or three asses were the only wild animals that we saw. Several of the wells on the caravan trail were dry. It would be a difficult country to cross except during an unusually wet season, and the trail gave evidence that it had not been used for a long time; probably seldom since 1921 when Soviet-controlled Outer Mongolia placed prohibitive taxes on passing caravans and the trade with Chinese Turkestan was diverted to the Winding Road south of the frontier. There was not a sign of exposures which might contain fossils. The topography consisted of a series of short, low mountain ranges paralleling the Altai system. The inter-mountain basins, fifteen to thirty miles in width, were filled with materials eroded from the mountains themselves, which were composed of pink and white marble, red granite, quartzite and slate. No ravines, gullies, bluffs or sedimentary deposits were to be seen. It was quite evident that we should have to go far to the south to reach low basins where sediments might be exposed. In the entire trip we

were always above five thousand feet altitude. As gasoline was running short we retraced our way over the pass by which we had come and reached camp without difficulty.

A PECULIAR MALADY

In the afternoon, McKenzie Young developed a high fever, and by the time we reached Kholobolchi Nor he was feeling very ill. His was the first case of a peculiar malady which attacked all of us with the exception of Olsen and Granger. Doctor Loucks said that the symptoms somewhat resembled those of influenza. He believed that it was induced by camping on the grassy shelf beside the lake, which was very damp, due to the presence of underground water close to the surface. This was the only time during all our work in Mongolia that any member of the Expedition, either native or foreign, was seriously ill. Young, although one of the strongest men of the party, had the most severe attack of the malady and was on the sick-list for two weeks. The fever left him extremely weak, as was the case with all of us.

THE FOURTH OF JULY, 1925

The Fourth of July was a delightful day: perfect weather, not a breath of wind, and the lake like glass. Chaney, Loucks, Shackelford, Berkey and Morris were away, but the rest of us celebrated by loafing in the sun, reading, writing and bathing. At night a dinner for which I had provided before leaving Peking gave us something to remember all our lives.

THE FISH OF THE TSAGAN NOR REGION

During the night of our return to camp a strange thing happened. We were awakened by fish! A strong wind blew from the west until about two o'clock in the morning, pushing the water in the shallow lake over to our side. Suddenly the wind dropped and the water receded so quickly that thousands of small fish which had been feeding close up under the bank were left stranded on a strip of mud about three feet wide. Flapping wildly as they tried to work back into the water, they made a noise like scores of people softly clapping their hands.

When I was awakened by the noise close to my head, I stepped out into the brilliant moonlight to learn what was going on. Thousands of glittering forms were flashing along the shore. I called Granger, Buckshot and others of the Chinese. With our twenty-foot seine they brought in hundreds of fish at every haul. We had some fried for breakfast, but they were too soft and "muddy" to be very palatable. The Chinese, however, liked them immensely and spent hours salting and drying them in the sun for future use. Most of these fish were about eight inches long, but Shackelford brought

back the head of one of the same species from Orok Nor which indicated an individual at least two feet in length. All the fish that the men obtained in Orok Nor were like those of Kholobolchi Nor. But the fish in Tsagan Nor, only thirty-five miles to the east and in the same drainage depression, are of quite a different species. This is strange, for Orok and Tsagan Nor must have been connected not many thousands of years ago.

Probably the fish were brought in by streams that flow, or have flowed, into the lakes. Still, how these desert bodies of water were stocked with fish is not entirely clear. In some cases it may have been by means of birds which carried fish or eggs from one lake to another. Just what happens to the fish when a lake dries up and remains dry for some time is also puzzling. Tsagan Nor, which was well-stocked with fish in 1922, had dried up entirely on July 16 when we returned. Would the fish all die and the lake have to be re-stocked, or would some of them manage to exist by burrowing into the mud? If the latter is true, they would have to go down a considerable distance, because the surface of the mud already had dried almost as hard as flint in many places and was deeply cracked. I imagine that Tsagan Nor could receive a fresh supply of fish from its inlet, the Tatsin Gol, when that stream revived sufficiently to fill the lake again.

BATS IN THE GOBI

One day Granger and Olsen brought in thirty-two bats, besides a great mass of tiny naked "batlets." They had caught them with their hands in the crevices of a cliff. Also they had two young horned owls and two of a smaller species. But owls do not make interesting pets, and they soon found their way into the specimen boxes. The scarcity of bats in the Gobi is interesting. We saw only a very few and those at not more than three or four localities. Doubtless this is due to the desert dryness which is favorable to but very few insects.

CHAPTER XXVIII

WESTERN AND SOUTHERN EXPLORATIONS

RECONNAISSANCE WESTWARD FROM KHOLOBOLCHI NOR

On July 10, Granger, Berkey, Lovell and I started westward from Kholobolchi Nor on a reconnaissance trip. Our object was to get a general view of the region at least as far as the longitude of Uliassutai, and explore the basins which lie parallel with the Altai Mountains on the north side. Even though there was every reason to believe that the basin sediments continued for a long distance, before I took the entire fleet westward I wished to be sure that there was opportunity for effective work; particularly, because we did not have sufficient gasoline to go forward on a fruitless expedition. To move our seven cars one mile required almost a gallon of gasoline unless the terrain was exceptionally fine. Leakage of gas, as invariably happens, had been heavy, and the hot days followed by cold nights gave the worst possible conditions for carrying our motor fuel.

Granger already had visited exposures thirty miles west of camp and, to our amazement, they proved to be almost the last that we found. The first day we traveled one hundred miles without crossing a fossiliferous exposure. Seventy-five miles from camp, we saw, far to the north, a line of red badlands, evidently an extension of the Oligocene, Loh formation, but the glasses showed them to be so thin and they were so difficult to reach that we did not investigate further.

Roughly, the structure over which we passed was an extension of the great Mongolian Bathylith with inclusions of limestone and gneiss at certain points. The valleys were floored with sediments, but there were no exposures. The country was extremely uninteresting and monotonous. The vegetation consisted only of Gobi sage and a few low, thorny plants; no wild asses and few gazelles of either species. Even the sand-grouse seemed to have deserted the region, leaving it stark and dead.

THE BAIDARIK GOL

We camped the first night at the Baidarik Gol, a large river which flows into the lake, Boun Tsagan Nor. The lake itself is fifteen or twenty miles

south of the trail and we did not visit it, but the natives said it was a considerable body of water. On the way we passed one other lake, about the size of Tsagan Nor but dry at the time, as well as several ancient basins with beautifully marked beach levels. This whole region must have been dotted with lakes and very well-watered by streams during the moist climatic cycle which preceded the dry epoch in which we are now living.

Baidarik Gol runs in a wide valley and, where the trail enters it, divides into three branches. It is deep in places, but we crossed it with the car along the line of ripples without difficulty. In the river valley, and also farther to the west, there were signs of irrigation, indicating that there had been an attempt at agriculture in the not very remote past. Probably this was the work of Chinese who were stationed at this post. On the west bank, on a bluff overlooking the valley, is an ancient watch-house made of hard clay bricks which would resist weathering for a long time. About three miles to the south we examined the ruins of what evidently had been barracks. During the Manchu rule in China this must have been an important station for the administration of the post road. It is reported that gold has been found at the Baidarik Gol in considerable quantities, and I believe that the Russians have done some work along the stream, but there is no evidence of recent operations.

After making camp we examined the high west bank of the river. At a distance it appeared to be a fine exposure of sediments but inspection proved that it is formed of very old gneiss. The valley is the home of hundreds of wild ducks, geese and sand-grouse. The many fire holes evidence that it is a favorite halting place for caravans bound to Uliassutai and Kobdo. Indeed, two large Chinese caravans were camped on the east bank when we arrived. They were loaded with tea, sugar, cloth and tobacco, and would bring back sheep and camel wool, hides and ponies.

TO THE SASSAKTU KHAN MOUNTAINS AND RETURN

On the second morning we stopped for tiffin at a collection of yurts beside a large pond. The Mongols told us that the trail divided there, one branch leading north to Uliassutai, and the other southwest to the province of Sassaktu Khan. The northern trail they said soon branched off to the Naribanchi monastery, about forty miles away. There lives a famous lama hypnotist who was well-known to the Mongols at our halting place. Ossendowski, 1922, refers to this "Lama Avenger" in his book, "Beasts, Men and Gods."

We followed the southwestern trail for some miles and stopped at a dry salt lake, with a mountain barrier in front of us. Two much-frightened Mongols who were gathering salt told us that they were the Sassaktu Khan Mountains and that the principal monastery of the kingdom lay only a short distance beyond them.

By this time we were almost south of Uliassutai and had not seen sedimentary exposures of any kind, although we had crossed several basins. The chances of finding fossiliferous deposits farther west were so poor that we decided to return and not attempt to traverse the mountains. At best, such a crossing was certain to be difficult and little was to be gained. We returned to camp at Kholobolchi Nor on July 13.

SIDE TRIPS FROM KHOLOBOLCHI NOR

A party went to investigate a small area of red sediments between Baga Bogdo and Ikhe Bogdo. They were gone for two days and found not a scrap of bone, although the deposits were splendidly exposed. Morris and Olsen made a trip of several hundred miles to the north while we were off in the west, and had found no profitable exposures. Our western trip had demonstrated that we should have to go beyond the longitude of Uliassutai before it would be possible to find basins containing exposed sediments; moreover, there was little to indicate that such deposits did exist. We had seen most of the territory in the Gobi between the Altai Mountains and the northern grasslands. Nothing remained for us but to retrace our steps to Shabarakh Usu, leave the main camp there and send an exploring party to find a way through the Gurbun Saikhan range. South of those mountains we might discover important deposits and new geological strata. At any rate it was a region which must be investigated.

THE DISAPPEARANCE OF TSAGAN NOR

Our departure from Kholobolchi Nor was made July 16, and we reached Tsagan Nor for an early tiffin. As I have remarked, the water was gone. In place of our beautiful lake, a wide expanse of white mud lay stark and dead. A lone sheldrake sat disconsolately in the center of the vast open space, the only remnant of the clamoring flocks of wild fowl which had rested on the water when we left. We had much amusement with Roberts, who had spent so many days with Butler and Robinson in mapping Tsagan Nor. We told him that he had mapped a lake which did not exist; we would tolerate no "faking" on the Expedition and he would have to throw his map away.

COMPLETENESS OF BURIAT DOMINATION

At Artsa Bogdo we camped at the spring near the trail while we tried to hire ponies from the natives. Chaney wished to botanize on the mountain while Young, Loucks, Butler and Robinson hunted sheep and ibex. Most of the ponies near the spring belonged to a near-by yamen, we were told. The Buriat officials keep the Mongols in absolute terror. We had the greatest difficulty in buying sheep, hiring ponies or getting any assistance, although

these people were old friends. They said that virtually everything they had was under the direction of the yamen.

A DUNE DWELLER JASPER QUARRY NEAR SHABARAKH USU

After starting the men for Artsa Bogdo in one of the trucks, the rest of us continued our trip to Shabarakh Usu. Thirty-six miles from that place the trail led us over an exposed ridge of red jasper. Lying about upon the surface were thousands of partly-worked artifacts and a few completed instruments of chert, chalcedony, agate and red jasper. Many of the specimens appeared to be so primitive in their workmanship that we believed them to be Mousterian or earlier. We spent some time there, collecting many hundreds of artifacts, and then went on to Shabarakh Usu, pitching our tents at the camp site in the basin.

The spot never seemed more beautiful than when we returned to it after the disappointment of our western trip. Nelson, who had stopped to investigate several promising archæological sites with Morris, did not arrive until some time later. He entirely disagreed with our assumption that the artifacts we had found along the trail were Mousterian. He said, in his opinion, the exposure of the jasper ridge represented the source of supply for implement material for the Dune Dwellers of the entire Shabarakh Usu region. It was a primitive "stone quarry" where they went to obtain their stone; the crude workmanship represented "test pieces" in his opinion, chunks of stone which had been thrown away as unsuitable after a few flakes had been removed. He believed that the primitive artisans, after selecting the material, returned to their permanent camps, such as at Shabarakh Usu, to finish the implements.

Nelson started a hot controversy in camp. We were not at all willing to abandon our idea of a new early Palæolithic culture without a fight. Berkey returned with Nelson to reëxamine the site and the rest of us marshaled every argument we could think of to defend our position. But Nelson set about demolishing our theories one by one in the most cold-blooded way. He had the advantage of knowing a lot more about the subject than we did. After he had arranged a series of specimens in rows, showing the entire method of flaking from its beginning to the finished artifact, we had to admit that he was right and that the crude specimens were test pieces.

Such discussions are most valuable. The Expedition's work is so correlated that every discovery affects the other branches of science directly or indirectly. Therefore, when a man advanced a new theory he had to be prepared to defend it from a half-dozen angles. If it survived the attacks from the whole staff he could feel that it was probably correct. It was because of these constant discussions in camp that I had no hesitation in making very

definite statements when the results of our summer's work were announced each year to the world's press after we had returned to Peking.

RECONNAISSANCE SOUTH OF THE GURBUN SAIKHAN

While Olsen and Shackelford remained at the Flaming Cliffs, hunting fossils, Granger, Berkey, Lovell and I left camp for a week's exploration of the little-known country south of the Altai Mountains. The Russian map showed a great basin directly south of us across the frontier of Inner Mongolia. The map is so inaccurate that quite possibly no such basin existed, but the region was worth exploring. If it was a low-lying area of sediments, it would probably contain fossils. No trails were shown, and, since the Mongols said none existed, we prepared for a grueling trip.

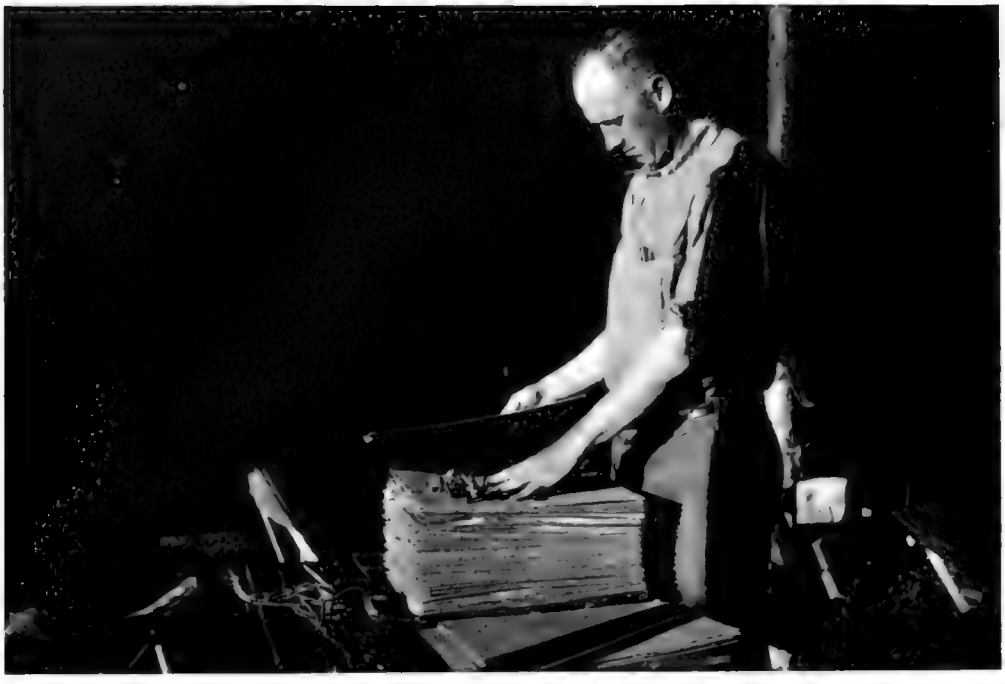
Thirty miles from camp, the Gurbun Saikhan Mountains—the "Three Good Ones"—rose to a ragged horizon of low peaks. We could see a deep cut, which looked like a pass, and we drove up to it on a beautiful slope covered with short grass and wild onions, all in flower. The rocky gateway proved to be the entrance to a dry river-bed. It led us in and out among rounded hills and over lovely upland meadows to a spring of cold, sweet water just over the summit of the pass. Right beside it we saw fine exposures of red sediment, but not a fossil bone could we find in an hour's search. Some time earlier the geologists had discovered a fragment of dinosaur bone in similar sediment to the east, so that they felt sure that it was Cretaceous. The Altai Mountains, they had determined, were a late uplift, which had been pushed through the old sediments in Tertiary times. On top of the Cretaceous lay a deposit of Pleistocene, also barren of fossils.

From the southern exit of the pass we looked into a vast basin with exposures of red sediment on all three sides. But a day and a half of prospecting and more than a hundred miles of traveling showed us that it was almost barren of fossils. We had a most instructive example of how the country is cut and eroded by sudden storms. For an hour the Gurbun Saikhan, ten miles away, had been obscured by sheets of falling rain. Suddenly we heard a muffled roar and saw a flood of brown water advancing upon us down the slope. It came so fast that I had to run to keep abreast of it. The chocolate-colored flood stripped off a thin layer from the surface of the plain, leaving in its wake new ridges and furrows. Thus goes erosion in such a land.

Though, as the Mongols said, no caravan trails led southward, we made three attempts to cross the desert, where the mountain ridges lowered to the plain. Twice sand turned us back. On the third day we were successful, and for more than a hundred miles we plowed southward over heavy terrain. Difficult passes let us through low mountain ranges, and in one we had a narrow escape. When we had run rapidly up the smooth slope of a low hill

PLATE LXXVI.

CARAVAN LEAVING CAMP AT CHIMNEY BUTTE, 1928.



A. [illegible] PACKING A COLLECTION OF BOTANICAL SPECIMENS, 1925.

B. TYPICAL MONGOLIAN OXCART.

and over the crest, a gorge thirty feet deep suddenly opened in front of us. Lovell threw on both brakes, stopping the car six inches from the edge. I nearly had heart failure as I looked down into the ravine through the windshield. We were out of that car in about a second and a half. Then the question was how to get it back from the edge. If the machine slipped over, we could walk to camp some two hundred miles away or stay there and die of thirst. The brakes were holding, but a good strong puff of wind was all that was needed to end our automobile ride. Eventually we worked the car back inch by inch after blocking the rear wheels with stones so that it could not move forward. That was one of the narrowest escapes of our whole summer in Mongolia. Had the car crashed into the ravine, the Expedition would have been shy four of its members.

The country we were crossing was hopeless from our point of view. Narrow, ragged mountain chains paralleled each other east and west; between them were sedimentary plains uncut by ravines or gullies, so that there were no exposures in which to look for fossils. We pushed steadily southward to the edge of a vast area of ragged lava hills swept with yellow sand. From the summit of the highest peak we could look forty miles across this sea of desolation to the blue ramparts of a mountain chain that rimmed the basin we had hoped to reach. Nothing on wheels could cross that sand-drenched chaos; a camel might have done it, but a horse would have been ruined in an hour. To circle it was out of the question without more gasoline than we had to spare. The impossibility of getting through was so obvious that it tempered our sense of defeat. Had there been a chance, we should have turned back more sadly.

When plowing up to another pass ten miles to the west, we discovered a solitary yurt tucked behind a mass of rocks. A half-dozen Mongols ran out frantically, signaling us to stop. It was a yamen, or official post, on the frontier of Outer Mongolia. A more useless place for a yamen could hardly be imagined for we had not seen a sign of habitation in many miles.

THE FIRST ARGALI SHOT FROM AN AUTOMOBILE

While we were returning through a mountain pass just before dark, two great brown animals leaped into view on the saw-tooth rim of the highest peak. Lovell saw them first. "Sheep, as I'm alive!" he shouted. There they stood, two magnificent rams, silhouetted against the sunset sky. Granger's rifle was in the car beside me. As Lovell switched off the power, I fired, sending my bullet into the quarters of the larger ram. I wonder if any other man has ever shot a mountain sheep from a motor car! I have killed a good many bighorns but never one that did not exact strenuous work. Sheep-hunting means hard climbing, skilful stalking, straight shooting. To sit comfortably

in a touring car and pot a Mongolian argali, the trophy *par excellence* of a sportsman's life, was a new experience. Incidentally, it gives an idea of where we had taken that car about as plainly as it could be told. I am not surprised that the sheep were too curious to run away when the roaring black thing appeared among their mountain peaks. Our being there seemed so strange even to us that at times we could hardly believe it true.

EASTWARD ON THE SOUTH SIDE OF THE GURBUN SAIKHAN

The discovery of a caravan trail, the Great Mongolian Road, paralleling the Altai Mountains, sent us eastward next day for more than a hundred miles into a most arid desert. It was a bare gravel floor without even the stunted "camel sage" and wild onions which are able to exist where there is almost no rain. Carcasses of animals marked the track, telling an eloquent story of what a toll of life the desert had exacted from the last caravan that passed this way. A short distance from the trail lay the body of a man. What had been his story? We wondered if he had lost in the battle with thirst and hunger or had yielded his life to disease, alone in the silent spaces of the desert.

The eastern exploration was as unproductive as that to the south had been. Low ridges of Mesozoic igneous rocks and inter-mountain basins of undissected sediments formed an uninteresting assemblage to a fossil-hunter. Since there was no indication that the country would change for a long distance, we returned to camp at the Flaming Cliffs. We saw a few gazelles in the desert area and one wild ass, which is the most eastern record for the species. The exploration had taken us six hundred miles, and, although we were bitterly disappointed in not discovering new fossil beds, the negative knowledge was valuable. A vast area had been eliminated from our future calculations, and the fact that we had already investigated the most interesting regions of Outer Mongolia had been determined.

A RUMOR OF WAR IN CHINA

During our absence, interesting things had occurred in our Shabarakh Usu camp. When Young and I visited Urga in late May, we had met a charming young Dane by the name of Birck, who was in the employ of an English company. This same young Dane had suddenly arrived in camp with a caravan of camels. His company had sent him to turn back a herd of ten thousand sheep which were on their way to Kweihwating, in North China. The sheep were to be diverted to Manchuria; just why, Birck was not sure. He believed that war in China was the only possible reason, and, indeed, at the time of our departure in the spring, it had seemed certain that Chang Tso-lin and Feng Yu-hsiang would fight. If there was war, the sheep would have been a heaven-sent food-supply for either of the foes. George Olsen is also a Dane.

It developed that he and Birck had come from the same little town in Denmark; their families had lived only a short distance apart, and Olsen knew Birck's father. Of course, we all made the usual remark about how small the world is, after all!

The war news was somewhat disturbing. If Chang and Feng were really fighting, the conflict probably would be near Kalgan or along the Mongolian border. In that event, either army would welcome our motor cars with open arms when we returned. I did not worry unduly about the prospect, since it was only July 25 and there was ample time for the war to be over before we reached China on September 15. Meantime it was possible that we might get more information. Birck had remained at camp only one day; for he was obliged to rejoin his caravan, which was plodding eastward toward a yamen sixty-five miles off. There he was to await the arrival of his sheep.

A "ZERO HOUR" WINDSTORM

The morning after our return to Shabarakh Usu from the southern trip we had an interesting experience. It was the "zero hour" just before daylight when consciousness is drowned in heaviest sleep. Suddenly I sat up, wide awake, with a strange feeling of unrest vibrating every nerve. Slipping out of my fur bag, I stepped through the wide angle of the tent door. In the air was a stillness vaguely depressing. A cold nose touched my hand, and Wolf, our police dog, whined unhappily. He pressed hard against my legs, stretched his head toward the Flaming Cliffs and gave a long howl that sounded to me like the wail of a damned soul. It made me shiver, and I buckled a cartridge-belt and a revolver over my pajamas before circling the tents with Wolf close beside me. All was quiet. Even the camels, kneeling in two long double lines, nose to nose, were sleeping. It was the tomblike stillness that was so disturbing. Back in the tent, I made sure that Walter Granger's revolver was in its usual place beside his head. Then I slid into my fur bag while Wolf squatted in the door with his nose high, sniffing restlessly. I did not like it and could not sleep.

At the end of fifteen minutes, I slowly became conscious that the air was vibrating to a continuous even roar, which was getting louder every second. Suddenly I understood it all. One of the terrible desert storms was on the way! As the first blast bellied in the tent, filling it with a whirl of sand, I ducked into the sleeping-bag and pulled the flap tightly over my head. A minute later the "wind-devil" had passed and I heard muffled curses from Norman Lovell. His tent was down, and under the mass of blue cloth I could see a writhing hump. Eventually Lovell emerged, laughing as usual. "I'm all right," he shouted, "but this tent looks like the wreck of the Hesperus. I'm going back to bed." Dragging his sleeping-bag clear of

the debris, he crawled in, happy as a marmot in a new hole. The "wind-devil" whirled and danced away across the desert and left the air heavy as a pall. In the gray light of dawn we could see an ominous bronze cloud hanging over the rim of the basin to the south. Evidently there was more of the storm to come, but, since it might miss us, we decided not to wake the camp. Ten minutes later the air shook with a roar louder than the first, and the gale struck like the burst of a high-explosive shell. Even with my head covered I heard the crash and rip of falling tents. It was impossible to see, but I felt for Granger with one foot. He was lying across a green suitcase, his face protected by a shirt. As our tent swept away, he had leaped to save the box that contained six tiny fossil Cretaceous mammal skulls, the most precious treasures of all our collections. For fifteen minutes we could only lie and take it. While I was feeling for Granger, the sleeping-bag had been torn from under me and the coat of my pajamas stripped off. The sand and gravel lashed my back until it bled, and poor Granger on the mammal skulls fared no better.

Suddenly the gale ceased, leaving a flat calm. The camp was completely wrecked. All of the fifteen tents were down, and men were slowly emerging from the debris, swearing good-naturedly in English, Chinese and Mongol. Our tent was split from end to end, and its contents were piled in the most chaotic mass I have ever seen. A trail of litter showed the path of the wind toward the "tamarisks" where the Dune Dwellers lived twenty thousand years ago. The "tamarisks" looked like Christmas trees, each one bearing fluttering streamers of shirts and trousers and dabs of snowy cotton. A half-dozen chairs and folding tables had been smashed. Basins, clothes and plates were sucked into the whirling vortex, carried hundreds of feet into the air and scattered over the desert for a half-mile. Had our cars not been facing the wind, they certainly would have been overturned. Never have I known so violent a gale. It must have reached a velocity of one hundred miles an hour. Fortunately, it had passed in fifteen minutes and there was an interval of calm before we had to face the wind again. Every man considered it a joke. While we hunted in the growing light for our belongings, without a suggestion from me the cooks made coffee and fried antelope steak. In a half-hour breakfast was ready.

THE EXPEDITION REASSEMBLED AT SHABARAKH USU

Late in the afternoon of the same day, Nelson and Morris returned from an examination of new Dune Dweller sites. Morris was ill with the same malady that had affected almost all of us at some time during the past month. He had violent chills and fever and an intense aching all over the body. Doctor Loucks said it was more like influenza than anything else.

July 27 was another windy day. Granger and Lovell went out with a Mongol who had reported exposures northeast of camp, but they proved to be unimportant. The same afternoon, Tserin rode into camp on a pony with a message from Young, who had stayed with the party at Artsa Bogdo. He wrote that the truck clutch had broken and asked for a new part which we had in another car. I sent the Chinese chauffeur, Wang, in one of the cars with food and spare parts, and the next day the men arrived. They had killed eight ibex, one with forty-one-inch horns. They said that there were virtually no sheep on the mountain this year. Formerly we used to see almost as many sheep as ibex, but for some unaccountable reason they had suddenly deserted Artsa Bogdo. It was delightful to have the entire Expedition assembled again. There was much to talk about, for every group had had interesting experiences.

"BIGGER AND BETTER EGGS"

Olsen had made an important discovery the previous morning. In the extreme eastern end of the basin he found twelve dinosaur eggs buried in soft sand. They were by far the largest and finest that had been discovered and amply justified the slogan, "Bigger and better eggs" for the 1925 Expedition. The eggs had dropped out of a low sandstone shelf which was considerably weathered, and Olsen had only to brush them out of the sand. The eggs were elliptical and about nine inches long. In fact, they were nearly the shape of a loaf of French bread. Their beautifully striated shells showed a variety of patterns on the same egg. Only a short distance from them, Liu Hsi-ku discovered another nest of the long, slender, thin-shelled type. Quite evidently the second lot was the product of a different species, and probably genera, of dinosaurs. The new additions brought our collection of eggs for the year up to thirty-five or forty, including the specimens which were somewhat broken.

GOOD-BYE TO SHABARAKH USU

Since our exploration south of the Altai Mountains had not produced positive results in the way of new fossil fields, the only alternative was to return to Ula Usu, where we knew there were extensive unexplored deposits. I had left this region as a reserve in case the far western Gobi did not prove as interesting as we expected. On August 2 we left Shabarakh Usu with much regret. This single spot had given us more than we had dared to hope from the entire Gobi Desert. The first dinosaur eggs known to man, a hundred skulls and skeletons of new dinosaurs, eight Mesozoic mammal skulls and the primitive human culture of the Dune Dwellers, all had come from a few square miles in this lovely basin. Is it surprising that I was filled with

regret as I looked for the last time at the Flaming Cliffs, gorgeous in the morning sunshine of that brilliant August day? I suppose that I never shall see them again! Perhaps some day I may view the cliffs from the window of a trans-Gobi train, but my caravan never again will fight its way across the long miles of desert to this treasure-house of Mongolian pre-history. Doubtless it will be the hunting-ground of other expeditions for years to come. We have but scratched the surface, and every season of blasting gales will expose more riches hidden in its rocks. Who can tell what will come from a place that has already given so much?

CHAPTER XXIX

THE END OF THE 1925 EXPEDITION

A SECOND ACCIDENT AT CLUTCH CAMP

When, a few miles east of Shabarakh Usu, in 1922, the clutch of one of the trucks broke while we were crossing a small sand-wash, we named the spot "Clutch Camp." In 1925 a like accident happened to a truck in exactly the same spot. It delayed us two hours, but we camped at night forty-three miles from the Flaming Cliffs and eleven miles from the yamen where the young Dane, Birck, was awaiting his sheep. Lovell drove over with one of the men to inform the yamen that our camels were coming in a few days and to let them pass. Birck returned with Lovell to our camp for the first decent dinner that he had had since his last visit with us. He had been living on Mongol food ever since leaving Urga.

HUNTING BIGHORN SHEEP BY AUTOMOBILE

Birck spent the night at camp and waved us farewell as our cars roared away in the morning. The going was excellent and we made good progress. We had been playing with scattered herds of antelope along the trail, waiting to pick up two or three yearling bucks for meat, and my car was a mile in advance of the fleet. An exciting run had just ended and two fat gazelles were slung on the fenders of the car, when Doctor Loucks shouted to stop. Half a mile to the north lay a low, ragged mass of rocks, the root of an ancient mountain peak. On the very summit, silhouetted against the sky, stood two magnificent bighorn sheep quietly gazing at us. The glasses showed us that they carried superb horns, great circlets at least fifty inches in length.

It was McKenzie Young's turn to get a sheep, so we waited for his car to arrive. Meantime, the animals remained motionless as though carved from granite. Not until we were less than a quarter of a mile away did they slip over the crest and disappear. We could not find those particular sheep again, but they gave us an idea. Jichi Ola—an elongate, rugged mass of

sediments—rose abruptly out of the plain fifteen miles to the east. It also should have sheep and perhaps we could get them from the car. I had shot a fine ram while on the southern trip, and it would be a decided novelty to hunt one of the wildest and most difficult of big game animals from the cushioned seat of an automobile!

The tents were pitched close up against the base of Jichi Ola. This is one of a number of low eminences which continues the trend of the Altai far to the east beyond the Gurban Saikhan. Each is a simple and single ridge. Each has been much worn down and is girded by a broad rock-shelf about the base. Jichi Ola is about eight miles long and three miles wide. It stands four hundred feet above the level of the alluvial fans about its base. On all sides the arid reaches of the desert undulated like the swelling surface of a vast brown sea. A hundred yards behind the cook tent, Shackelford flushed a woodcock. A bird of paradise would have been no more out of place than this shy inhabitant of wooded swamps out there in the center of the Gobi! But we realized that the woodcock was migrating southward and had lost its way. Wisely it had chosen to lie concealed among the rocks until night came and it could resume its journey safely. In 1922 at Ardyn Obo I had found one in a similar place.

Four or five of us hunted the next day, and most of the men got sheep, but they were all in the highest peaks. Doctor Loucks returned in the afternoon to report that he had killed a wolf and two sheep toward the end of the mountain; he thought we could get fairly close with an automobile. Robinson, Loucks, and I skirted the base of the ridge in the touring car and almost immediately saw two sheep standing on one of the higher peaks. They ran toward us as we advanced, apparently fascinated. Keeping the engine running, we stopped. "Robbie" slipped behind a rock and at four hundred yards knocked over a young ram. Evidently the time had come to hunt from the car, for as shadows lengthened the sheep worked out from the peaks to the lower slopes to feed. By careful manipulation we worked the car through rocky gateways far up into valleys which cut deep into the mountain. The roar of the engine echoed like a machine-gun among the cliffs, but it seemed to attract rather than frighten the animals. We saw fifteen, I believe, and shot three—not such a bad record for bighorn sheep, especially when we sat comfortably in a motor car all the while! I think none of us will ever forget the drive back to camp through a narrow defile. Exactly in the center of the gateway hung a crescent moon partly eclipsed, which threw a wan, unreal light among the rocks. In the path of our headlights, kangaroo rats leaped and danced like elfin sprites, and once the dim shadow of a wolf crossed into the darkness of the plain.

The next day while Granger was visiting a red outcrop which stood

isolated on the desert four miles from the mountain, he came upon a band of female sheep led by a young ram. Following them in his car for a mile or so, he found that the highest speed they could reach was twenty-five miles an hour. They tired quickly, however, and finally gathered into a compact group. Running up to within a hundred yards of them he stopped. The sheep looked at him as much as to say: "It's your next move." While he was trying to get his camera they decided to leave and the group suddenly separated, each one dashing wildly for the nearest point of rocks.

OBSERVATIONS AT GOLOBAI-IN-OLA

Our next stop, August 6, was at Golobai-in-Ola at the entrance to a beautiful rocky canyon. It was a perfect place for a camp, wild and rugged, beside a dry stream-bed piled with huge boulders and dotted with poplar trees. We stopped at a yurt a few hundred yards away where there was a lame woman about forty years old. The poor woman tried to run when she saw the car and then stopped, trembling violently. Utterly terrified, she could hardly talk, but we gave her two cigarettes and Tserin assured her that she need have no fear. When we drove down to the spring in the car, a young girl dived behind a boulder like a rabbit; when she saw that she was discovered she leaped for the side of the canyon and ran up the rocks. An hour later after the tents were pitched we sent Tserin up to inquire about renting some ponies. The yurt was gone. In that short time the inmates had disappeared with all their sheep. The only things that remained were the two cigarettes which I had given the lame woman, carefully placed on a stone where the yurt had been.

Berkey and Morris found that this was a key point for determination of the relation between the granites and graywackes and wished to remain a day for a closer study. Everyone was delighted, for it was such a beautiful spot that it would have been hard to pass it by. Butler, Robinson and Loucks hunted sheep the next day but they saw only ewes. The lack of game may have been due to the excessive aridity of this entire region. There was almost no vegetation on the mountain ridges.

CHROMITE ORE AT GUTUL USU

We continued eastward on August 8, and that night camped at a well named Gutul Usu. A few miles to the north of Gutul Usu Doctor Berkey discovered a deposit of low-grade iron which contained a good deal of chromium, at Lat. 43° N., Long. 108° 20′ E. He saw about one hundred tons lying on the surface three miles north-by-east of the well. Were fuel and transport available, it would be a valuable deposit; as it is, the iron is worth little. This is the only spot in which we had found minerals of any value in all the

country we had investigated. North of the desert there is considerable valuable metal, but we did not go into that region.

EXPERIENCES AT A BORDER YAMEN

On August 9, we reached the yamen where our caravan had been detained in the spring. It was at the point where we should again cross the frontier into Inner Mongolia. We were curious to know what would happen. I carried enough documents from the Urga government to paper half a room, but in the spring they had been ignored by these Buriat officials. All summer we had had with us an officer of the Secret Service, part of whose duty it was to see that there was no more difficulty at the yamens and to vouch for the Expedition. Of course, he was there principally to report upon our activities, but as we had nothing to conceal and he was quite a decent fellow, he did not annoy us.

At the border yamen on August 10, we dropped our Secret Service official and his bags. The entire personnel of the yamen had changed since our last visit; whether my complaints in Urga were responsible for the change, I do not know. The new officials appeared to be of the same type. A hard-faced Russian was in charge and an insolent young Buriat surveyed our cars with a supercilious smile but made no comment about them. The officials promised to let our caravan pass, but that, of course, meant nothing. We told the officials that in a few days we would send two cars up to the caravan for gasoline, and they promised to let them pass.

RETURN TO INNER MONGOLIA

When the yamen had been left behind and we were once more in Inner Mongolia we felt like celebrating. We got information that as yet there was no fighting in the Kalgan area, but that was all.

A few days later when Lovell and Roberts appeared at the yamen with the trucks, they met the same unbearable insolence. Guns were drawn on both sides, but when the Buriats saw that our men would not be stopped they allowed them to go.

Although the officials had promised faithfully not to interfere with our caravan, we took no chances. From Shara Murun six of us drove a hundred miles back to the yamen. We were all heavily armed and determined to enforce the privileges given us by the Urga government. We were a grim-looking party when our car roared up to the yamen, and the officials could see easily enough that we did not intend to argue with them concerning the right for our camels to pass. It was a great relief when the entire Expedition was across the border. We camped at Ula Usu for a few days while Berkey and Granger made a reconnaissance to the northeast along the west side of

the Shara Murun valley. They found what they believed were very rich fossil deposits.

PLANS FOR CLOSING THE 1925 SEASON

The work of the topographers was virtually finished and Shackelford could use the time to great advantage in Peking developing films. Moreover, I wanted to know definitely about the political situation. I had no wish to run into a war where our cars and equipment would doubtless be confiscated by one of the contending generals. Therefore I decided to go in with two cars, leave Butler, Robinson and Shackelford in Peking and return for another month in the field. Chaney also decided to go. He had done all that he could in the palæobotanical line and he was anxious to complete his collections of living plants by going through the grasslands where the autumn flowers were then in bloom.

DOCTOR CHANEY'S SUMMARY OF HIS BOTANICAL WORK

Doctor Chaney has the following general statements to make about the botany of the regions we visited:

"The botanical collections comprise between four hundred and fifty and five hundred species, of which there are four trees—willow, poplar, birch and elm; about thirty bushes and shrubs, two vines and the remainder herbs. The most abundant families are the grass family with more than twenty species, and the pea family with about thirty species.

"On the dry desert plains which comprise the most extensive habitat, the characteristic plants are several species of bush pea with yellow and pink flowers, the salt bush which is especially common in sandy places, the plains onion which is certainly the most abundant plant individually in Mongolia, and the camel sage. During the rainy season a large number of herbs come up, including thistles, iris, morning glory, vetch and grasses.

"Bordering the lakes and swampy places, the tamarisk, a tall bush with pink bunches of flowers, is common, together with iris, buttercups, sedges, and reeds which may reach a height of eight to ten feet.

"In the mountains the variety of plants is greatest, with marigolds, poppies, orchids, forget-me-nots and daisies giving color to whole grassy meadows. There are many bushes, including a gooseberry and a bush-honeysuckle which is the favorite food of the ibex. In the canyon bottoms cottonwoods and willows grow on the flats, and under the rocks there are a few delicate ferns. On the rocky slopes the rhubarb, mentioned by Marco Polo in his early account, is abundant.

"The grasslands in Inner Mongolia also have a great variety of plants, among the most abundant being mints, daisies, thistles, asters, legumes and

many grasses. Along the stream courses are low elm trees, which in the dryer areas are no more than a foot or two tall when full-grown.

"The Mongols have few sources of plant food. The rhubarb, the onion, of which a giant species grows in the mountains, the dune-berry, and in some cases the grain from a tall grass are the only ones known to be eaten. A great many plants are used for medicine; the ashes of a small mint called by the Mongols *temen-sul* (camel's tail) are put on burns and wounds; the root of *Ephedra* (Mongol name *dzergene*) is used for rheumatism; a small mountain dandelion (called *tzetz-serba*—stinging yellow) is a cure for headache and fever, the dried flowers being ground and made into tea; and a tall aster, the Tibetan name of which is *ruda*, meaning sour root, has roots which are used for stomach trouble.

"A few plants are used for making baskets and pails, including the willow (*burgase*, meaning flexible) and the cottonwood (*toree*, meaning hollow). The bark of the willow is used for tanning leather. All of the larger bushes are used for fuel where available, especially the salt bush and the greasewood, which is called *cheren-tule*—blooming fuel. Various plants have a part in religious ceremonies, especially the *artsa*, a low juniper growing in the mountains, which is burned as incense in the temples, and a tall grass called *deresen* which is burned as a sacrifice to evil spirits.

"Many of the Mongol names for plants have attractive meanings, as *botula*, a small white mountain flower, the name meaning "the flower that makes the hills beautiful"; a slender grass called *zormasu*, meaning mouse-tail; a bush called *emegenschylbe* or woman's calf, because it is so graceful; and a thorny pea called *khargana*—with needles.

"Further studies of the distribution of the living plants of Mongolia will, it is hoped, throw light on the past climate. At the present time, only the trees may be mentioned in this connection. In the deep canyons on the side of Ikhe Bogdo there are birch trees growing, and in the canyons and washes along much of the Altai, cottonwoods are common. Neither of these trees can grow in the surrounding lowlands, nor could their seeds, even though winged, be blown the several hundred miles from the nearest forest on the Arctic Divide. It may be concluded tentatively that these trees represent relics of a forest once continuous or at least widely distributed over Mongolia; reduction of rainfall may be supposed to have destroyed this forest in the Gobi proper, leaving only a few survivors in the protected mountain canyons."[1]

PHOTOGRAPHING A GREAT HERD OF ANTELOPE

A few days before we started for Peking, Shackelford had an opportunity to photograph the greatest herd of antelope that I have ever seen. We dis-

[1] Chaney, R. W., Personal communication.

covered them one morning six miles from our Ula Usu camp, streaming up to the plains out of a great basin. Thousands upon thousands of bucks, does and fawns poured in a yellow flood over the rim and spread out like a vast fan upon the upland. Shackelford had his motion-picture camera strapped in the back of the car and we worked with the herd for hours. But it was rather unsatisfactory because so long as they remained on the flat plain they appeared in the pictures only as a long line of moving animals.

It was certain that they would not travel far, for the feed was excellent where they were. Therefore, in the morning we went out again as soon as the light was strong. This time they had arranged themselves as though directed by a stage manager; perhaps fifty thousand were in the bottom of an enormous valley where from the rim we could "shoot" down at them with the telephoto lens. There was a light wind and for the first time in my life I could *smell* live antelope. A mile away the squalling of the babies could be heard. With the glasses we could see them nursing and playing. All the intimate details of domestic antelope life were carried on before our eyes. Sometimes a thousand or so would dash at full speed through the center of the herd, only to stop abruptly and begin to feed. The mass was in constant motion; hardly for a moment was any part of it stationary, although the animals were entirely at peace.

I was surprised not to see wolves in the vicinity. One might think that such a vast gathering would have attracted wolves from miles around, but as a matter of fact wolves are remarkably scarce in Mongolia. After we had watched our antelope for nearly an hour and exposed a thousand feet of film, we dashed down the long slope directly into the herd. We were almost on them before they decided that it was time to really run. Then it was most amusing to see them leap over each other to avoid the car; with ears laid back the babies put every ounce of strength into the race and for a mile or two they could do fully as well as their parents. The herd divided into many units and we chased one after another until the plain was alive with antelope running wildly about in search of their husbands, wives or children. But within a few hours they had again collected into a compact mass, and in the afternoon we saw them from afar as a splash of yellow on a vast green canvas.

As I have remarked, it is only the grassland species, *Procapra gutturosa*, that gathers into such vast herds. In the spring just before the young are born, the females collect on a flat plain and separate as they drop their young. In the fall, bucks, does and fawns again assemble. The long-tailed desert species, *Gazella subgutturosa hillieriana*, never herd. Doubtless that is because no spot on the desert where they live could give sufficient feed for more than a hundred or so.

A TRIP TO PEKING

We left Ula Usu for Kalgan with two motor cars just after a heavy rain, and in the afternoon had an experience which might easily have cost us a car. A dry river-bed barred our way. Butler and Chaney prospected it and waved me to come on. Fortunately, there was a fairly steep bank on the other side and I started across at forty miles an hour. Suddenly, "plop!" I had a sickening sense of everything going out from under me as the car dropped into a quicksand well. It was the same type of death trap into which the *Baluchitherium*, whose legs we found, had sunk some millions of years ago. Had we not had another motor with us, a million years from now someone might have excavated a fossilized Dodge Brothers car in just the same way. The quicksand was narrow and the speed of the car had carried its front wheels across the well. The rear end was sunk at a dangerous angle; with the "pull out" cables on the other motor car we drew it to firm ground.

There had been an unusual amount of rain during the summer and the grasslands were blazing with flowers. Chaney reaped a harvest of new species, for we had arrived at just the right time; a week later many of the flowers had withered. As we neared Kalgan we began to get bits of information regarding the political situation in China. There was no war, but that always disturbing element, the Chinese student, had engineered a strike and a boycott on British business firms. It had been going on all summer; that was why Birck had had orders to intercept his sheep and divert them to Manchuria. The news was comforting so far as we were concerned, for evidently it was quite safe to proceed to Kalgan.

Peking was seething with excitement; therefore it was enjoying itself hugely. It seemed very strange to come into the flower-filled courtyards of my house and don formal evening dress within a few hours of leaving Mongolia. But I had given myself only three days in which to enjoy civilization. As soon as a few necessities had been collected and I saw that the needs of the men who had returned were attended to, Young and I returned to Kalgan.

RETURN FROM PEKING TO BARON SOG

Some intimate friends of mine, the Danish Minister, Mr. H. de Kaufmann, and Mr. and Mrs. Mason Sears of the American Legation, were contemplating a trip to Urga, so I invited them to visit our camp near Baron Sog, en route. Mr. Robert Williams took them in his car.

Floods of rain had converted the grasslands into veritable bogs and we had rather a messy time of it on the return journey; instead of two days, it took us four to reach camp. The Shara Murun, in place of the usual dry stream-bed, had become a raging torrent. With the greatest difficulty we managed to negotiate a crossing. In doing so we were cheered by the sight

of our blue tents almost opposite to us on the high west bank of the valley. The camp was pitched on the very rim of the basin, four miles north of the Baron Sog monastery.

NEW TITANOTHERE FOSSILS NEAR BARON SOG

After we had eaten tiffin, Granger took us out to the fossil fields. He and Berkey had reached the conclusion that they were dealing with a new geological horizon, probably Lower Oligocene. George Olsen had exposed several specimens, but the most interesting was the skull of an extraordinary beast that Doctor Loucks had discovered. We had not the remotest idea what animal it represented. In fact it was not described until after the 1928 Expedition, when others of the same genus were discovered across the valley. It proved to be a titanothere, representing a new phylum. Professor Osborn, 1929, named the specimen *Embolotherium loucksi*. I will describe this remarkable beast in more detail in a later chapter.

The specimen was in such bad condition that one with less experience and patience than Walter Granger would have been unable to remove it at all. The bone literally was in powder and could be blown away. Granger soaked it first with gum arabic, which cemented the minute particles together; then he stippled on Japanese rice-paper, and when this was dried he was able to expose a little more of the bone and repeat the operation. Eventually it was bandaged with strips of burlap soaked in flour paste which formed a hard shell.

The morning after our return to camp, Granger came in to report that Chih, one of the Chinese collectors, had discovered an enormous skull. We all went down to watch the excavation, for that is the most interesting part of fossil collecting. Just the tip of a great bone was exposed, and as Granger worked away the surrounding matrix, it proved to be the occipital part of a skull. It was so large that at first we supposed it to be another *Baluchitherium*, but as the work progressed it became evident that what we had was a titanothere. The frontal region was gone so that we could not see whether it had carried a great forked horn as did the American Oligocene titanotheres, but the teeth were excellently preserved.

ANCIENT HUMAN GRAVES NEAR BARON SOG

Meanwhile Nelson had found a rich field in the same area which produced the fossils. On a gravel slope facing west were twenty or thirty piles of rock which indicated human work. They were in orderly arrangement and he was convinced that they must represent burials. It required considerable effort to remove the rocks, for some of them were huge slabs sunk several feet into the earth. Two graves were empty, but one produced inter-

esting results. First, he encountered heavy timbers beautifully preserved; under these lay the perfect skeleton of a man. He must have been five feet ten or eleven inches tall. Beside him lay a birch bark quiver filled with arrows. Some of the shafts were of wood; others were partly of reed tipped with wood. The points were iron but the metal was badly corroded and in poor condition. The bow had separated into half a dozen pieces.

To me the most interesting thing in the grave was a saddle, upon which the man's head was resting. He must have worn a turban, for bits of the cloth still adhered to the skull. The saddle was well-preserved, and when Nelson brought it to camp it proved to be a perfect McClellan type such as our army uses to-day. We had several with us, and the similarity was amazing. General McClellan without doubt thought that he had developed a new saddle, just as we supposed that we were the original discoverers of the dinosaur eggs. But in both cases primitive dwellers of Mongolia had made the discoveries centuries before we were born. The saddle is quite unlike that used by Mongols or Chinese to-day or in the past, so far as I am aware.

Nelson thought that the grave must be at least a thousand years old and possibly more than that. The fact that it was placed in a well-drained slope, in an extremely dry desert, undoubtedly accounted for the splendid preservation of the wood and bones. It was impossible to identify the skeleton in the field, but its racial characters can be determined by study at the Museum.

AN OLD, ABANDONED COPPER MINE NEAR ULA USU

Berkey and Morris found evidences of other prehistoric people in rather an interesting way. They were sitting in a Mongol's yurt, twenty miles from Ula Usu, when Berkey's attention was caught by a small nugget of copper ore lying on the family altar. The Mongol was definite in his information that it came from a spot quite near a temple fifteen or twenty miles to the south. The geologists visited the place and found evidences of surface mining operations on a large scale. A vast pit had been excavated in the hillside; so large, indeed, that at first they did not believe it could be artificial. The copper was not in veins, and the deposit had been so thoroughly worked that but comparatively little remained. They studied the place carefully and came to the conclusion that the mining operations must have ceased at least a thousand years ago.

A VISIT FROM THE GREAT ANTELOPE HERD

While we were at the camp where Nelson had found the grave, the antelope herd which Shackelford had discovered paid us a visit. We heard them pouring down into the basin during the night, and two days later the whole

PLATE LXXVIII.

ANDREWS, GRANGER, YOUNG AND THOMSON REPACKING SUPPLIES AT HATT-IN-SUMU, 1928.

PLATE LXXIX.

A. A MONGOL LAMA.

B. RED LAMA.

C. MONGOL WOMAN OF THE KHALKA TRIBE NEAR URGA.

D. A CHAHAR MONGOL WOMAN OF THE SOUTHERN GRASSLANDS.

mass came up again not more than four hundred yards from camp. While we were at breakfast the bleating of the fawns and the "tap tap" of thousands of tiny hoofs brought us all out of the tent. A vast yellow blanket of moving forms was flowing over the edge of the bluff onto the plain. Wolf, my police dog, went wild with excitement. He chased group after group until he was exhausted, but the antelope could leave him behind so easily that they bothered to run only when he was almost upon them.

LAMA SUPERSTITIONS AT BARON SOG-IN-SUMU

When we were ready to move to another fossil locality, we asked the priests of the Baron Sog monastery for permission to deposit our specimens in their care until the caravan arrived. We had done this half a dozen times during the preceding two years. They said that we could leave gasoline or rocks, but no fossils, because last summer many horses and sheep had died in the vicinity and that doubtless it was due to the bad influence of the "dragon bones."

Our next camp, ten miles to the north of Baron Sog-in-Sumu, was very similar to the one we had left. The tents were pitched on a great promontory which projected far out into the basin. Near them was an obo, or religious monument, and shortly after our arrival two lamas came to call. They were delegates from a temple, Tukhum-in-Sumu, four miles away, and asked us to be particularly careful not to shoot or kill any birds or animals on the bluff. It was a very sacred spot and the spirits would be angry if we took life in the vicinity. Of course, I agreed to respect their wishes and gave orders at once. But we had promised more than we could fulfill, as events proved.

VIPER CAMP

In the first two hours of prospecting, three pit-vipers, *Agkistrodon*, were discovered close to the tents. A few days later the temperature suddenly dropped in the late afternoon and the camp had a busy night. The tents were invaded by an army of vipers which sought warmth and shelter. Lovell was lying in bed when he saw a wriggling form cross the triangular patch of moonlight in his tent door. He was about to get up to kill the snake when he decided to have a look about before he put his bare feet upon the ground. Reaching for his electric flashlamp, he leaned out of bed and discovered a viper coiled about each of the legs of his camp cot. A collector's pickax was within reach and with it Lovell disposed of the two snakes which had hoped to share his bed. Then he began a still-hunt for the viper that had first crossed the patch of moonlight in the door and which he knew was somewhere in the tent. He was hardly out of bed when an enormous serpent crawled out from under a gasoline box near the head of his cot.

Lovell was having rather a lively evening of it—but he was not alone. Morris killed five vipers in his tent, and Wang, one of the Chinese chauffeurs, found a snake coiled up in his shoe. Having killed it, he picked up his soft cap which was lying on the ground and a viper fell out of that. Doctor Loucks actually put his hand on one which was lying on a pile of shotgun cases. We named the place "Viper Camp," because forty-seven snakes were killed in the tents. Fortunately, the cold had made them sluggish and they did not strike quickly. Wolf, the police dog, was the only one of our party to be bitten. He was struck in the leg by a very small snake, but since George Olsen treated the wound at once, he did not die. The poor animal was very ill and suffered great pain, but recovered in thirty-six hours.

The snake business got on our nerves and everyone became pretty jumpy. The Chinese and Mongols deserted their tents, sleeping in the cars and on camel boxes. The rest of us never moved after dark without a flashlight in one hand and a pickax in the other. When I walked out of the tent one evening, I stepped upon something soft and round. My yell brought the whole camp out, only to find that the snake was a coil of rope! We had to break my promise to the lamas and kill the vipers, but our Mongols remained firm. It was amusing to see one of them shooing a snake out of his tent with a piece of cloth to a place where the Chinese could kill it. The vipers were about the size of our copperheads, or perhaps a little larger. While their fangs probably do not carry enough poison to kill a healthy man, it would make him very ill.

The snakes inhabit bluffs throughout the desert, like the one on which we were camped. Their great number at this particular spot was due to the fact that it was a sacred place and the Mongols would not kill them there. This viper appears to be the only poisonous snake in the Gobi, and we collected but one non-poisonous species. The climate is too dry and cold to favor reptilian life.

HOOFED ANIMALS OF EOCENE TIME

The new camp proved to be just as rich in fossils as it was in snakes. One place which evidently had been the bed of a stream that had flowed there during Eocene times was a veritable quarry of fossil bones. Twenty-seven jaws were exposed at one time in the same layer, and it was necessary only to scrape off a few inches of sediment in almost any spot to uncover valuable specimens. We got skulls of a peculiar beast known as the *Chalicothere*, a veritable paradox. It is a "clawed-hoofed animal." The head and neck are like those of a horse, the teeth like a rhinoceros, and the feet like nothing else on earth. Instead of hoofs the creature was armed with claws. Why such an anomaly was developed no one can tell. There must

have been some good reason, for nature does not produce such extraordinary appendages haphazardly, but thus far the explanation is obscure.

The region must have swarmed with a little hoofed beast known as *Lophiodon*, for the palæontologists obtained a great collection of jaws and skulls which represent many unknown species and genera. We found no trace of horses in the very old formations. This is a great surprise, for the unknown five-toed ancestor of the horses is one of the types which we confidently expected to discover. Four-toed horses are present in the Eocene of both America and Europe, and we are certain that the ancestral stock developed in Asia, but as yet it has eluded us. Nevertheless it must be there, although I have come to believe that it will be found in southern Siberia rather than in Mongolia.

RECONNAISSANCE TRIPS NORTH AND WEST FROM VIPER CAMP

Berkey, Lovell and I drove north in the Shara Murun valley for sixty miles to the border of Outer Mongolia. There we were stopped by yamen officials with the usual insolence. They would not recognize our passports as valid, although we had just come across the frontier. Doubtless we could have made them let us pass by showing force, but it did not seem to be worth while and we turned back. Off to the east, on the opposite side of the valley, we had dimly seen red exposures which in 1928 proved to be rich fossil deposits.

While work was proceeding at Viper Camp, six of us made a five-hundred-mile exploration south and west. It was an attempt to find a trail which would take us out to Chinese Turkestan through a little-known region of Inner Mongolia. We hoped to explore that part of Mongolia during the next expedition. We discovered a trail, but since we followed it in 1928 I will reserve my description of it until the narration of that Expedition.

END OF THE 1925 EXPEDITION

When we returned from the southern trip the caravan was awaiting us at the Baron Sog monastery. Rain and light snow warned us that it was time to leave if we were not to be caught in the bad weather of early winter. The sand-grouse were flocking and golden plover had arrived in thousands from the Siberian tundras. On September 12, we drove down the slope to the basin floor, leaving Viper Camp to the snakes and vultures. Another season had ended and we were well content.

STUDY OF THE CRETACEOUS PERIOD IN ASIA

After the 1925 Expedition, Professors Berkey and Morris studied the Cretaceous period in Asia as a whole and suggested the following inferences

as to conditions during this closing period of the Age of Reptiles, approximately 100 million years ago:

"1. The continent of Asia in Cretaceous time was relatively low lying, and was bounded on the north, south and southwest by shallow epicontinental and mediterranean seas.

"2. There may have been in Cretaceous time a series of near shore elevations, ranges that foreshadowed the mountains of to-day, and that occupied the places where the modern ranges stand. The erosion of these ranges would yield sediment to the sea on the one hand, and to the inland basins on the other; but no deposits would ever form along their site. This inference seems to fit in well with the observed facts.

"3. The primitive trachydont dinosaurs of Asia may have given more advanced descendants to Europe and even to America. The highly specialized ceratopsians of America may have been derived from the primitive Asiatic forms, though it is not necessary to derive them directly from the Djadochta species. The presence of large sauropods also suggests intercourse between Asia and other lands, especially America. But the isolation of the faunas in Oshih-Ondai Sair and Djadochta time must be due to barriers of some sort. The barriers may have been seas, such as Borissiak and Grabau have postulated along the western Siberian lowland; or deserts, giving areas of uncongenial environment. Mountain barriers and isothermal barriers are unlikely, because no mountains that are likely to have existed in that period could have been so uniformly long and high as to prevent migration, especially of upland faunas such as the Djadochta types. The Cretaceous was a period of mild, equable climate even in the far north, so that frigid zones did not shut in the faunas as they do to-day. Whatever barriers kept American and European hordes from invading Asia, and for a full period withheld Asia's evolving dinosaurs from Europe and America, probably were either water bodies or deserts which could not be crossed."[1]

[1] Berkey, Charles P., and Morris, Frederick K. (MS. for Vol. III, this series, in preparation).

CHAPTER XXX

WAR PREVENTS THE 1926 EXPEDITION

WINTER ACTIVITIES OF THE STAFF

SHORTLY after returning to Peking from Mongolia in 1925, Berkey, Morris and Roberts left for America. Shackelford soon followed with twenty thousand feet of motion-picture film which he had developed in our laboratory in Peking. Lieutenants Butler and Robinson returned to their respective military duties, and Doctor Loucks resumed his work at the Peking Union Medical College. Granger and Nelson prepared for a winter along the Yangtze River, the former to continue his exploration of the fossil pits of Yen-ching-kou, near Wanhsien, Szechwan, the latter to examine the numerous caves along the river banks in the hope of finding evidences of palæolithic man. It was imperative that I should return to America to obtain additional financial support for the Expedition and to stimulate public interest by lectures and writing. Affairs in Peking were left in charge of J. McKenzie Young, assisted by Norman Lovell.

A FOSSIL REDWOOD FOREST IN MANCHURIA

Doctor Chaney went northward into Manchuria to examine reported deposits of plant fossils. Before he left America he had told me of his hope to find the remains of redwood forests in eastern Asia, and his prediction was fulfilled at the Fushun Mine of the South Manchurian Railway Company, thirty miles east of Mukden. There, in shales above and below the coal, he discovered fossil plant remains, the most abundant of which was the redwood *Sequoia langsdorfii;* other species were the alder, oak, maple, sycamore, poplar and fern. This fossil assemblage is almost identical with the Bridge Creek flora of Oregon, which is referred to the Upper Oligocene. Both of these fossil floras are closely similar to the redwood forests now living on the coast of California.

While it was known that redwoods occurred in eastern Asia during Tertiary time, no indications of the existence of a considerable forest had been

reported. The presence of the other trees, which are so characteristic of the living redwood forests, leaves little doubt that a forest approximating that of California formerly was present in Manchuria. Doctor Chaney found additional evidences at the Pataoho Mine of the Fengtien Mining Administration. It is probable that the forest extended continuously to Vladivostok, where similar fossils have been found.

Since the living *Sequoia* must have at least forty inches of rain a year for its best growth and does not thrive in regions of extreme climate or low rainfall, it may be inferred that its Oligocene equivalent of Manchuria and Siberia required about the same conditions. The rainfall at Fushun to-day is less than half the amount necessary to maintain a forest of this type. In discussing the fossil flora of Mongolia and Manchuria and the climatic conditions which they indicate, Doctor Chaney remarks:

"Little is known of the pre-Cretaceous floras of Mongolia except that trees grew on the borders of streams and that their stems were transported as driftwood and deposited in the sand and mud at the rivers' mouths. In the course of subsequent mountain-making movements, the characters of these early plants have been largely obliterated. The presence of a varied flora in the Permian of eastern Chihli suggests that conditions for plant life may have been more favorable there than in Mongolia during the Palæozoic.

"The Cretaceous flora of Mongolia appears to have been made up of good-sized trees, mostly of coniferous types, which occupied the borders of lakes together with rushes. There is no record of the vegetation of the uplands where *Protoceratops* lived; these were doubtless occupied by grass and bushes, but the distance to the streams and lakes was too great for them to be left in the sedimentary record. From the fact that plant remains are not more numerous, the climate during the Cretaceous may be supposed to have been fairly dry, so that the trees were limited in number and distribution.

"The Tertiary flora of Mongolia enters even less into the geologic record, suggesting a climate still more arid than that of the Cretaceous. This suggestion is borne out by the comparatively small size and the twisted character of the fossil stems, which in these respects closely resemble the gnarled bushes now growing in Mongolia. The almost complete absence of leaf impressions is a strong indication of aridity, for if there had been many water bodies the leaves would have been preserved in the clays instead of disintegrating in the air as they appear to have done. To the east and south in southern Manchuria, climatic conditions appear to have been much more favorable for tree growth. During the Oligocene, there was a luxurious redwood forest which may have extended continuously to Vladivostok.

"It appears probable that the great difference in rainfall between Manchuria and Mongolia during the Tertiary was due to the range of mountains

between, which cut off most of the rainfall from Mongolia in much the same way as it does to-day. A similar situation is now to be found in California, where near the coast the rainfall is high and redwoods and other trees flourish, while in the interior, to the east of the Sierra Nevada, trees are almost entirely absent. The scarcity of fossil plants in the Tertiary of Mongolia may best be interpreted on the basis of such an arid or semi-arid climate, and the evidence of the vertebrates is quite in accord with such an interpretation."[1]

Doctor Chaney remained in Manchuria for some time and then went to the Philippine Islands before returning to America.

PREPARATION OF FOSSILS IN CHINA

George Olsen fitted out my former large office at headquarters in Peking as a laboratory in which to prepare the fossil collections. Under Olsen's expert direction, the five Chinese field collectors began to turn out completely restored specimens fully as quickly as could have been done in the American Museum of Natural History. Establishing this field laboratory was somewhat of an experiment, for we were by no means sure that the specimens after restoration could be safely shipped to America. I may say, however, that our greatest hopes were realized. Not only did the fossils reach New York with virtually no breakage, but the cost of preparation was about one sixth what it would have been in the Museum. Chinese are notably skillful with their hands, and by the end of the year our native preparators were well nigh as good as those in New York.

THE STAFF FOR 1926

The 1925 Expedition, with a foreign staff of fourteen men and twenty-six Chinese and Mongols, proved to be too large. Our mobility was sacrificed and it became unwieldy for the country in which we were operating. It required too much gasoline to move, and too much food to maintain, the party. I had come to the conclusion that a foreign staff of ten was the maximum number that we could use effectively. I intended to organize the 1926 Expedition on that basis.

Since Doctor Berkey could not leave his work at Columbia University for the next year, R. H. Beckwith, one of his students and an Oxford Rhodes scholar, was substituted as geologist. It was impossible for Major Roberts to return, and he was replaced by Captain W. P. T. Hill, U. S. Marine Corps, who was detailed to the Expedition through the kindness of Major-General Le Jeune, and of the Honorable Curtis D. Wilbur, Secretary of the Navy. Captain Hill had had much experience in Alaska and other parts of the world, and combined a considerable knowledge of geology with expert training as a

[1] Chaney, R. W., Personal communication.

topographer. Dr. W. D. Matthew had long wished to study the Mongolian fossil fields, and we all were delighted when Museum affairs were so arranged that he could join the Expedition.

OUTBREAK OF CIVIL WAR IN CHINA

Just after I had sailed for America in October, 1925, the ship's radio picked up news of a civil war which had started near Shanghai. It caused me no worry because Shanghai is a long way from Peking and I did not believe that the war would spread northward. Even if it did, the northern Chinese never fought in the winter. I thought that it would last for a few weeks and then be settled in the usual Chinese manner, without much bloodshed. But it was just that year when things began to change in China and tradition and "good form" in the conduct of wars were completely smashed. The trouble did spread to the north like a flame and lasted all winter. Some of the bitterest fighting was in December and January near Tientsin. The second breach of "good form" was that they killed a good many people. Thousands of wounded poured into the city and the countryside was strewn with dead. The railroad transport of all north China was paralyzed; for weeks no trains ran between Peking and Tientsin, although, according to the 1900 Protocol, the foreign powers have the right to maintain communications from the capital to the sea. Food was expensive and difficult to obtain. It was not a question of how soon a thing could be done, but whether it could be done at all. Therefore McKenzie Young had his hands more than full with preparations for the spring expedition.

Just about the time he had everything ready, renewed hostilities began. Gradually the "People's Army" of the so-called "Christian General," Feng Yu-hsiang, was pushed back toward Peking. The only communication with Tientsin was by motors which were allowed to pass through the lines when there was no fighting actually on the road.

MOVING SUPPLIES FROM TIENTSIN TO PEKING

To buy tons of rice and flour, hundreds of pounds of sugar, coffee, beans and other food supplies in Peking was impossible. They had to be purchased in Tientsin, but that port is eighty miles from the capital, and no trains were running. Four thousand gallons of gasoline had been specially packed for us by the Standard Oil Company but it, with the food, was all in Tientsin.

Since our caravan must start in March at the latest, Young decided to bring the gas and supplies up to Peking by motor. It was a laborious and very expensive method, but there was no other way. For three weeks Norman Lovell made a round trip every day. Leaving Tientsin early in the morning, he drove the eighty miles over what is only by courtesy called a

motor road, and arrived in Peking at noon. While he was eating luncheon the car was unloaded and he was off again on the return trip to Tientsin before one o'clock.

During these days of transport he had many exciting experiences. The road swarmed with soldiers of one side or the other, and a more annoying collection of uniformed brigands would be difficult to find anywhere. He carried a large American flag on the car, but this did not prevent his being fired on time after time. There was a "no man's land" of ten or twelve miles between the opposing lines, and entering or leaving this area usually was attended with a good deal of danger. The advance- and rear-guards in the trenches not infrequently took a flying shot at the car just to see if they could hit it. Sometimes there was genuine suspicion that it might contain a machine-gun party of the opposite side, and the treatment Lovell received was distinctly unpleasant. Of course, he would be stopped and questioned every few miles, but cigarettes and a plentiful supply of calling cards usually were sufficient to get him through.

Just before I reached China in March, 1926, four new cars for the Expedition arrived from Detroit, for our fleet was to consist of eight Dodge Brothers cars. Lovell with three Chinese chauffeurs drove them to Peking. Unfortunately, they happened to start on the day that the so-called "People's Army" were retreating along the motor road. Thousands of troops and lines of carts blocked the way. Our cars were heavily loaded with gasoline, but the soldiers literally took possession of them. So many men piled upon each car that they could hardly pull even in low gear. The springs were absolutely flat and had they not been designed for especially rough work they certainly must have been ruined. The soldiers were very ugly, and the fact that the cars bore American flags and that the road was a recognized avenue of traffic for automobiles made not the slightest difference. Lovell's feat in getting our gasoline and supplies to Peking is, in itself, sufficient testimony to his courage and tact.

WARLIKE ACTIVITIES DELAY MOVEMENT OF SUPPLIES

It was the first week in March before our equipment was assembled at the Expedition headquarters in Peking. The caravan should have left with the equipment by mid-February. When the first war rumors developed in the early winter, Young had sent word to Merin, the Mongol caravan leader, to take our camels far out into the desert where they would be safe. Feng Yu-hsiang was confiscating every cart, mule, horse and camel within a hundred mile radius of Kalgan, and the American flag which floated over Merin's tent would not have protected our camels from the soldiers of the "Christian General" or any others.

Meantime all the railroad cars on the Peking-Suiyuan Railroad had been seized by the military. It was virtually impossible to move a pound of freight to Kalgan even by paying the most exorbitant "squeeze" for the use of a freight car. Sometimes a merchant did manage to get one started from Peking, but it was usually sidetracked at Nank'ou, half way to Kalgan, there to remain indefinitely. Young had tried by every means to get our supplies to Kalgan, without success.

RETURN OF THE LEADER TO PEKING

I arrived in Tientsin on March 27, 1926, with J. B. Shackelford, the Expedition photographer. There had been sharp fighting not far from Peking, and the authorities were loath to allow Young to drive to Tientsin to bring us up. His trip down was comparatively uneventful for those exciting days, although he was halted and questioned a dozen times by soldiers of both sides. When we returned two days later, the road had been mined in fourteen places by Chang Tso-lin, as preparation for a counter attack by the "People's Army." There were thousands of soldiers, but we had no trouble, although one became a bit jumpy when driving over the mines which we hoped were buried deeply enough not to explode from the impact of our motor.

GETTING THE EQUIPMENT TO KALGAN

A week after our arrival in Peking, I managed to get two freight cars for Kalgan through the influence of Mr. C. S. Liu, Director-General of Railways. He sent word at four o'clock in the afternoon that they were available but said that we must load them at once or they would be taken by the soldiers. We worked a good part of the night taking over the gas and supplies. One was a covered steel car and loopholed and bullet-marked; the other was a flat car upon which we drove two motors and piled them about with cases. Young and Shackelford chaperoned the things to Kalgan without serious incident and returned to Peking. Word had been sent to Reverend Joel Eriksson, a Swedish missionary, asking him to bring in the camels, and as soon as they arrived I expected to go up with Young to see them started.

AIR RAIDS ON PEKING

In the meantime Peking had been having daily visitations from an aëroplane which flew over the city every morning at ten o'clock and dropped eight or ten bombs. The plane stayed so high that its missiles were badly directed and did comparatively little damage. A few pedestrians or merchants were killed at every raid, but the aviator seemed unable to hit the barracks or railway stations which were his objective. Fortunately the bombs used were loaded with black powder and weighed only eight or ten

pounds; had they contained high explosives it would have been a good deal more serious.

After the first two or three days, Peking accepted the aëroplane visitations as just another of the nuisances caused by the stupid war, and characteristically proceeded to derive as much amusement as possible out of the experience. "Bombing breakfasts" became a new form of social entertainment. We used to gather at nine o'clock at the Peking Hotel, breakfast comfortably, and then adjourn to the roof at five minutes to ten. Promptly on the hour the plane would appear out of the sky to the south. After a preliminary circle we could hear the *z-z-z-boom* of a falling bomb, quickly followed by two others, for they invariably came in threes. Great clouds of yellow dust accompanied the explosions. The Chien Men railway station near the American Legation was a favorite objective of the airman, and the Legation Staff began to get a bit nervous. It was quite obvious that the bomber was trying to avoid the Legation Quarter, but his aim was so bad that an "egg" might land in the compound at any time.

On Monday morning, April 12, the plane appeared at nine o'clock, an hour earlier than usual. Flying over the South City, it dropped one bomb in a Chinese restaurant, killing five men and wounding three; the second landed in a primary school and killed several children; the third exploded in the middle of a street but did no damage. We supposed that the raid was finished for the day. I was due at the Hsichihmen railroad station at eleven o'clock to interview the Inspector regarding freight cars for our remaining six motors. Lo, one of my Chinese "boys," went with me.

Just as we were about to emerge into the broad esplanade fronting the station we saw people running in all directions. Lo shouted that an aëroplane was overhead, and the next instant there was a terrific explosion about thirty yards to the right of us. Fortunately the bomb had landed on the other side of a high mud wall which protected us from the iron fragments. I put on full speed, thinking to get into the depot for protection, but a second bomb exploded in front of the car and indicated that the airman was going in the same direction. We stopped abruptly. I leaped out of one door of the motor and Lo from the other. He rushed down the street and backed up against a wall. I dashed for some loaded freight cars standing on the track. An engine was just backing up to the cars and it was amusing to see the crew fly out of the cab and run in various directions at the crash of the second bomb.

With a dozen Chinese I crawled under the train. As the cars were loaded with bags of grain they gave fair protection. My car had solid steel wheels and I stretched out between them parallel with the axle. I was hardly in position when a bomb exploded with a deafening roar not fifteen feet from

my shelter. The steel fragments "pinged" against the car wheels like rain and I never realized how small I could make myself until that moment. A few seconds later two other bombs crashed almost simultaneously on the other side of the train. One steel fragment came in at an angle and buried itself within two inches of my face. I dug it out and burned my fingers nicely for it was red hot. After a few minutes all seemed quiet and I crawled out from under the train, thinking that the plane had gone. Instead it had only done a circle and was directly above my head. Before I could duck back under the train a bomb exploded a few feet away, directly in front of a Chinese woman. It blew her head off as neatly as though it had been severed with a knife. Another bomb landed in front of the wall where Lo had been standing and killed four men. Lo escaped only because he had at last obeyed my calls to come under the car.

The wretched airman seemed to have a special hate against that particular train and made three attempts to wreck it, dropping fourteen bombs within a few feet of it before he disappeared to the eastward. We were having rather a lively time, what with the noise and smoke and groans of the people who had been injured!

The Standard Oil Company own a tank which contained twenty-four thousand gallons of oil within a few yards of where half a dozen bombs exploded. Had one made a direct hit on the tank there would have been a most beautiful conflagration. Lo and I returned to the motor thinking we could finish our business with the Inspector, but it was useless. While we were in the station the airman returned and peppered us again. We decided then that it was an unhealthy locality and made a dash for safety. I was interested in the unconcerned attitude of the Chinese. An air raid is a nerve-racking experience for me, but the Chinese seemed to take it in the most casual way. At other times I have seen them thrown into a panic by a comparatively trivial thing.

NARROW ESCAPES FROM CHINESE BULLETS

On April 13 there was heavy gun-fire just outside of Peking, and after a dinner at the American Minister's, we adjourned to the roof of the Peking Hotel. The machine-guns showed in a steady stream of light along the southern horizon punctuated by the wide flashes of heavy guns. Hugh Bradley, of the Chinese Maritime Customs, who was leaving for America with his wife and child, tried to get through to Tientsin by motor, but shells were falling uncomfortably close and rifle-fire across the road drove them back. The American Military Attaché told me that the "People's Army" were noticeably stiffening and that they might even push the Fengtien troops back to Tientsin. But the usual thing happened. One of the generals of the

"People's Army" turned traitor, deserted to Chang Tso-lin with thirty thousand men, and the advance became a retreat.

I wanted to get through to Tientsin and made a try for it the next day with three members of the Expedition—Shackelford, Hill and Beckwith. We thought that a large American flag on the car would protect us as it had done in former years. The gates of Peking were heavily guarded, but the soldiers let us pass. Carts were already coming into the city loaded with grain, camp-gear and soldiers. Cavalry streamed by and then thousands upon thousands of infantry. They were retiring in good order and seemed most cheerful. An officer told me that Chang Tso-lin's troops had taken Tungchow, fourteen miles from Peking, and were looting the city but that no fighting was taking place.

We drove on slowly, and eventually passed beyond the rear of the retreating army. For three or four miles the countryside was deserted, houses closed and all as quiet as the grave. We were five or six hundred yards from the ancient marble bridge at Tungchow when there came the sharp crack of a rifle and a bullet struck beside the front wheel. A second later a mass of soldiers appeared on the road and bullets began spattering around us like hailstones. They had opened fire with a machine-gun, but it was aimed too low and the bullets were kicking up the dust just in front of us. The soldiers could see the American flag plainly enough but that made not the slightest difference.

Fortunately at this particular spot the road was wide enough for the car to be turned and I swung it about in record time. The bullets now were buzzing like a swarm of bees just above our heads. Forty yards down the road a sharp curve took us out of sight of the machine-gun. The other men crouched in the bottom of the car. Since I was driving I could see all the fun. It was a pretty rough road, but the speedometer showed fifty miles an hour as we went back. The ride became an exciting one. All the houses which had seemed so peaceful actually were occupied by the advance-guards of Fengtien soldiers. They had let us pass because of the American flag, but when they heard the firing in our rear and saw us returning at such a mad speed, they evidently thought that we were anybody's game. Each and every one decided to take a shot at us.

For three miles we ran the gauntlet of firing from both sides of the road. I would see a soldier standing ready with his rifle at the side waiting until we came opposite. Then "bang" he would let us have it. Sometimes they fired in squads; sometimes singly. The only reason why we were not riddled with bullets is because the Chinese soldier is the world's worst shot. Most of them aimed directly at the car, when they aimed at all, and the bullets struck just behind us. Every now and then one would zip in close to my head

but no one was hit. I really had the best of it because the others could not see what was going on and driving the car kept me busy. I expected every moment that one of the tires would be hit. A blow-out at that speed would have turned us over.

Before long we could see the rear-guard of the retreating army and the sniping at us ceased. Still our troubles were far from being ended. The first retreating soldiers, three of them, asked for a ride. I thought that they might be a protection and let them stand on the running board of the car. Suddenly one of them saw an officer. Without a word he stepped backward off the car, rolled on the ground with his right hand under the rear wheel. As I put on the brakes it ground his hand and arm into the hard gravel road. I have never seen such a sight; his hand was simply shredded. I put on a tourniquet to stop the bleeding but he was only anxious for us to go.

A little farther and we came to masses of infantry. Against my protests they piled on the car in such numbers that it could pull only in first speed. The inevitable happened when one fell off, breaking his leg. Things looked pretty bad. Three or four of the soldiers worked themselves into a rage, cocked their rifles and were just about to shoot us when an officer appeared. Fortunately he could speak Mandarin Chinese perfectly (the others talked a difficult Shantung dialect) and when I explained what had happened he cleared a passage so that we could drive off the road into the fields. With much difficulty we got through the gates back to Peking.

BESIEGED IN PEKING

Young went up to Kalgan on the evening of April 13 to see the camels started. On April 15, the day after our experience in trying to reach Tientsin, Shackelford and I decided to join Young in Kalgan. At eight-thirty in the morning when we drove to the Hsichihmen gate we found it closed and sandbagged. The soldiers said that no one could leave or enter the city. We made the rounds of the other gates and found them all heavily barricaded. The streets were deserted, the shops closed, and a strange air of preparation for a great calamity pervaded the city. If the Fengtien troops forced the gates, Peking would certainly be looted. Every Chinese of political importance who could find a lodging had fled to the Legation Quarter. Most of these same men had been loudly demanding the abolition of extra-territoriality and the dismissal of the Legation Guards but a few days earlier; yet at the first hint of danger they dashed to the foreign concessions as the only place of safety!

A good many foreigners who had cottages at the race-course, seven miles west of the city, were caught outside and had to remain there for several days in the midst of roving bands of soldiers. The First Secretary and the

Counselor of the British Legation tried in vain to get the guards to open the gates. At last they found a part of the wall where loose bricks had been removed by smugglers. A number of Chinese were on top and when the foreigners produced a silver dollar a rope magically made its appearance. The diplomats were hauled unceremoniously up the wall, losing a certain amount of "face" but at least getting to their posts in the Legation.

Notices were sent to all foreign residents in Peking by their respective Legations, instructing them where to assemble in the event of extreme danger; green lights and guns were the designated signals. From the concentration points the foreigners would be escorted to the fortified Quarter by armed guards. I had arranged for my family to go to the American Legation, but we had a carefully thought-out plan for the protection of my house and the great quantity of valuable equipment in the compound. With machine-guns posted on the roofs we should be able to present a pretty strong defense against any looters or even well-armed soldiery.

The "City Fathers" did some sterling work in persuading the Fengtien generals not to let their troops come into the city, urging that foreign complications would arise with the inevitable looting. The soldiers encircled the walls, but with the gates shut and sandbagged not a man was allowed inside. In the meantime the social life of Peking proceeded much as usual. The only fish we could get came from the lake in the Forbidden City, fruit was non-existent, and there was a shortage of fresh meat. However, nothing is allowed to interfere with dinners and dances, polo and tennis.

After a few days we discovered that Feng Yu-hsiang's army had retired up the railroad and entrenched themselves at Nank'ou, the pass through the Great Wall on the way to Kalgan. For many hundreds of years this pass acted as a strategic point protecting Peking from invasions of the Mongols and Tartars from the north. Now it acted in the opposite way by preventing the Fengtien army from following Feng's so-called "Christian soldiers" to their headquarters at Kalgan.

ARRIVAL OF MR. AND MRS. BURDEN

The third evening of our siege I was amazed at the arrival of Mr. W. Douglas Burden of New York, a Trustee of the Museum, and Mrs. Burden. They had reached Tientsin a few days earlier, and I telegraphed them to wait there until it was possible to bring them up. They had discovered that two men in a motor car were attempting to get through to Peking and took the chance of coming with them. Fortunately for them, they picked up on the road the Fengtien general in command of the air forces, whose car had broken down. He was one of the few men for whom the city gates could be opened. I was at the Chi Hua Men gate talking to the soldiers when they

asked me to please draw my car to one side as a very important general was arriving. The sandbags were being removed from one side of the gate, and when it swung open just enough to admit a car what was my amazement to see my friends come in! They had had an adventurous trip up from Tientsin. The human heads hanging from posts along the road and the evil-looking soldiery impressed them with the fact that their own lives were by no means safe. Their car was the first to come over the road, and Peking was keen to learn what was happening outside the city.

FAILURE OF EFFORTS TO REACH KALGAN

I had had no news from Young since he reached Kalgan on the last train that ran from Peking. Telegrams would not be sent, and although wireless messages were accepted by the Chinese station in the Temple of Heaven they never were delivered. I tried every possible means of communication without success. Finally the American Consul in Kalgan got a radio through to the Consul General in Tientsin, who forwarded it to the Legation. It said that our caravan had finally started on April 26, after having been commandeered three times by the soldiers in defiance of the permit given by the General in command at Kalgan. He had lost so much "face" over the matter that he furnished a military guard to see it beyond the limit of soldier activities. Young stated that he had tried to get down to Peking but had been turned back by the troops.

The days dragged on interminably for all of us. Doctor Matthew had arrived and Granger and Nelson reached Peking from Szechwan after an arduous trip. All the staff were assembled with the exception of Young, who was in Kalgan. The cars were loaded in the courtyard of the headquarters, and the Expedition was ready to leave at an hour's notice, but we were effectually blocked. Although the Fengtien troops were not pushing their advance against Nank'ou, heavy artillery fire could be heard every night in Peking.

I tried to get permission to go by way of Shansi and reach the Mongolian plateau west of Kalgan. Just when it seemed that it might be arranged, Feng's army advanced along the proposed route. Therefore our plans came to an abrupt halt. There was a lull in the fighting at the Nank'ou pass and I entered into negotiations for our passage through the lines. But the Generals said that as there was a good deal of guerilla warfare going on they felt certain that we would be killed if an attempt were made.

RETURN OF YOUNG FROM KALGAN TO PEKING

About two weeks later I was amazed to have a telephone message from Young. He had just arrived in Peking from Kalgan after a strenuous and

THE EXPEDITION AT GOLDFIELDS CAMP, 1928

adventurous trip. I went to the hotel and found him unshaven, gaunt and hollow-eyed. He had come by way of Shansi and had traveled about six hundred miles in order to get to Peking. Peking is only one hundred and twenty-four miles from Kalgan via Nank'ou. Young had walked a good part of a longer way, and the only food he could obtain were a few boiled and salted eggs. We got him into bed, and after a good many hours of sleep and some decent food he was fit and ready to do it over again if necessary.

He reported that food in Kalgan was very low. For weeks the foreign residents had had no coffee, tea, sugar, milk or butter, and but very little flour. Occasionally they could get fresh mutton. Cigarettes were entirely gone. Fortunately the British-American Tobacco Company had a large garden in their compound and by forcing the vegetables under glass the foreigners would be able to carry on for some time longer. Nevertheless, the situation was serious, for typhus had broken out, and the only doctor in town had died of the disease.

THE JEHOL-DOLON NOR ROUTE

Although Young had been able to get through both lines in Shansi, it was his opinion that it would be suicide to attempt it with six motors and a large party. We were certain, he said, to be annihilated by snipers even if we had permits and carried American flags. It wasn't good enough. Only one other possible route to the plateau remained; that was by way of Jehol, the old summer residence of the Manchu emperors, then over to Dolon Nor in Inner Mongolia, and down to Kalgan. Jehol is one hundred and forty miles from Peking, but the road is unspeakably bad. Lovell and I went in one of the Expedition cars, and I enjoyed the trip, for it took us through some of the most beautiful scenery in north China. A few miles beyond the An Tung Men, the north gate of Peking, we saw several thousand Fengtien cavalry coming across country at a sharp trot. They gave the appearance of retreating soldiers, but we were not molested by them.

Jehol itself is a beautiful spot and I was looking forward to enjoying the old palace and the tombs. But we found that the place was literally swarming with soldiers who were so obnoxious that we remained there only a few hours. I had a letter of introduction from the American Minister to the Military Governor and, after a considerable wait, was given an interview. The Governor was a former brigand but received me courteously in a small room at the extreme right of the old palace. The walls above the *kang*, or bed platform, on which he sat were hung about with automatic pistols, and I noticed that one was always within reach.

He would not even consider the suggestion of letting us through to Dolon Nor. He said that, were he to do so, he would be signing our death-warrant,

for the region was so infested with brigands and deserting soldiers that it would require a very strong armed guard to take us through his own lines. Doubtless he was right, for in his outer office I had talked with two of his tax collectors who had been fired on by brigand soldiers while on their way to a station a few miles from Jehol. In the city we visited a British missionary and his wife, the only foreign residents. They said that for months they had been in a state of continual unrest due to the soldiers who swarmed through the place. Both of them seemed to be pretty well shaken nervously, and I can well imagine what they had been through.

AN UNPLEASANT EXPERIENCE WITH ILLITERATE SOLDIERS

When Lovell and I returned to Peking, we had an unpleasant experience just outside the north gate. Although but few soldiers had been there when we went out two days earlier, the right wing of the Fengtien troops had retreated from the Nank'ou Pass and were entrenching themselves across the road. In spite of our American flag we were stopped by soldiers who treated us as though we were brigands. Our passports were quite in order, but unfortunately for us, the sergeant in charge could not read Chinese. For an hour this wretched guard kept us covered with loaded and cocked rifles while they searched the car and ourselves. In spite of my protests, the soldiers would neither take us to an officer who was able to read his own language, nor allow us to go. At the slightest motion on our part the boy soldiers (they were about sixteen years old) would throw their rifles to their shoulders. I indicated to our captor that the rifles might easily go off accidentally, in which case we would be killed. His only reply was "*Mayo fadzu*" (It can't be helped).

At last an officer who had enough education to read Chinese appeared. As soon as he had examined our passports we were allowed to proceed. Had we been killed even accidentally, they would have reported that we had attacked them and they had been forced to shoot in self-defense. The soldiers showed quite plainly that they had spent a most pleasant hour in annoying two foreigners who, in front of cocked rifles, were helpless.

ABANDONMENT OF THE 1926 EXPEDITION

There was always the hope that one of those sudden changes so frequent in Chinese politics would open the way for us, and it was not until June that I had to finally admit that the 1926 Expedition must be abandoned. Doctor Matthew returned to New York via India, and Shackelford went across the Pacific. Captain Hill was assigned to the American Legation Guard in Peking to remain until conditions would allow us to proceed. Beckwith set to work studying Russian for the winter.

KALGAN AFFAIRS AND THE CARAVAN

Our caravan had gone as far as Shara Murun and there had awaited word from us. Hearing nothing, they returned to Hallong Osso, one hundred miles north of Kalgan. One of the Mongols, Tserin, came in to learn what had become of us. He arrived just at the time when food in Kalgan was almost exhausted and the eighteen foreigners were facing real hardship. The American Consul managed to get a radio message to the Legation asking if they might take over our food. I immediately agreed and the supplies were brought to the city. The besieged foreigners sent us an enthusiastic note of thanks. It was not until mid-August that Feng Yu-hsiang's troops abandoned the defense of Nank'ou and retreated into Shensi. The "Christian General" fled to Russia via Urga where he at once renounced all his Christian doctrines. Chang Tso-lin set himself up in Peking as Dictator of north China.

WORK IN YUNNAN AND SZECHWAN

We had long wished to make a reconnaissance of Yunnan from the standpoint of archæology and palæontology. As conditions appeared to be normally quiet there, Nelson and Granger prepared to spend the winter in that beautiful province. From the experience I had gained on my 1916–17 Expedition, I was able to map out for them a tentative program, and they left in August for Yunnanfu.

Their previous winter's work in Szechwan had been interesting and valuable. Granger obtained a splendid collection of Pliocene mammals from the fossil pits at Yen-ching-kou, which supplemented his former work. Nelson was disappointed in finding no traces of palæolithic man in the caves along the river. Most of them had rock bottoms. He came to the conclusion that the river had not been used as a highway of travel until man had advanced far enough to learn the use of boats. He did, however, obtain a considerable collection of neolithic implements and of those representing the interesting pre-Chinese culture first discovered by Dr. J. G. Andersson.

LECTURES IN AMERICA AND IN ENGLAND

As there was little that I could do in Peking during the winter, I sailed from Shanghai on September first for America. Our fruitless summer had cost considerably more than would have been expended during a season's field work, and more money was urgently needed. I had also accepted an invitation to present the results of our explorations before the Royal Geographical Society in London as the Second Asia Lecture on November 10. My winter was a busy one and added some fifty thousand dollars to the treasury of the Expedition.

CHAPTER XXXI

PREPARATIONS FOR THE 1928 EXPEDITION

RISE OF THE ANTI-FOREIGN MOVEMENT IN CHINA

DURING the winter of 1926–27, important political events took place in China. The British concession in Hankow was forcibly taken by Chinese soldiers. To the stupefaction of all foreigners in China, the British Government not only made no attempt to reclaim it, but eventually officially returned it to China. Chiang Kai-shih, in command of the Southern army, was energetically making plans to attack the north with the object of bringing the entire country under the control of his party. He was ably assisted by the Russian, Borodin, and his army was directed by Russian generals. It had remarkable success and eventually moved on Shanghai with the openly avowed intention of taking that city and ousting the foreigners.

Flushed by their entirely unexpected success in the Hankow affair, the Chinese had decided that the Foreign Powers would not protect their interests and that if force were used all foreigners could be driven out of the country. They demanded the return of the Tientsin concessions and of the Legation Quarter in Peking. Propagandists, directed by Borodin, were active in all parts of China and particularly in the Northern armies. The "battles," which Chiang Kai-shih was heralded all over the world as having won against the Northerners, were farcical. Propaganda had done its work so thoroughly that usually the enemy retreated upon the appearance of the Southerners, or else deserted to their side.

The Foreign Powers had been driven too far by the advance upon Shanghai, and war vessels and troops began to arrive from all quarters of the globe. The British sent battleships and a large force, the first upon the scene. It is generally admitted that their prompt action saved a most horrible wholesale massacre of foreigners. An indication of what would have happened all over China was given at Nanking. A Southern army marched into the city, killed many foreigners, attacked the Consulates of several foreign powers, and began a systematic looting of every foreign house. Eventually the foreigners realized that they would be murdered to the last child and gathered on a hill belonging

PLATE LXXXI.

EXPEDITION CARS AT THE PEKING HEADQUARTERS, 1928.

STARTING ON THE 1928 EXPEDITION.

The American Minister, Mr. J. V. A. MacMurray, accompanied the Expedition to the top of the Pass. The cavalry was sent as an escort by the Chinese Government.

to the Standard Oil Company, where they were besieged by the infuriated soldiers. A gallant American Marine ascended to the roof of the building, and, while bullets were spattering all about him, signaled to the warships in the river. These immediately laid down a box barrage about the hill. As the first high explosive shell dropped near the house, the Chinese soldiers ran pell-mell in every direction. The foreigners were rescued by a landing party when the place had been cleared of Chinese soldiers.

Meanwhile thousands of foreign troops had gathered in Shanghai. Barbed wire entanglements were erected about the foreign concessions and the city put under martial law. A curfew rule kept all residents indoors after ten o'clock in the evening. One or two clashes took place with considerable loss to the Chinese, but no determined attack was launched against the concessions. The Northern forces, having been completely disrupted by propaganda, retreated, and the Southerners occupied the native city of Shanghai. All foreign legations had ordered their nationals from the interior of China, for it was quite evident that the Chinese intended to repeat the Boxer attempt of 1900 and kill or drive out every foreigner. Reports were continually arriving of murders and outrages committed upon foreigners in various parts of the country.

DISAPPOINTING RESULTS OF WORK IN YUNNAN

Such, in brief, was the situation when I reached Peking in early April, 1927. I came via Korea by train. Every ship out of China and every train was packed with departing residents, but coming to Peking I was the only foreigner on the entire train. At Tangku, not far from Tientsin, what was my surprise to see Granger and Nelson on the platform. They were just returning from Yunnan and we all came on to Peking together. Granger reported that their trip had been somewhat disappointing, They had first gone south and then east of Yunnanfu, because the western part of the province was so infested by brigands that the authorities would not allow them to enter it. They had discovered only one important fossil deposit; that was of Pleistocene age, but bandits drove them out after they had spent only three days there. Granger believed it to have most important possibilities and hoped to return for a further exploration. Nelson had fared little better. He had discovered no traces of Palæolithic man but had found further evidences of the Yangtze River Neolithic and pre-Chinese culture. I was sorry that they had not been able to explore the country to the west, for I believe that it will prove to be well worth investigating.

TENSE SITUATION IN PEKING

Upon reaching Peking we found that the foreign residents were thoroughly frightened. It was the first time that I had seen anything like a panic. Even

the year before, when the gates of Peking were closed and sandbagged, and Chang Tso-lin's wild Manchu hordes were looting and burning the countryside, few foreigners in the capital were even nervous. The Hankow and Nanking outrages, however, had inflamed the anti-foreign feeling which exists in the hearts of most Chinese. The poorly veiled hostility to foreigners by all classes made us realize that wholesale slaughter had been averted only by the arrival of foreign troops in China. The Southerners were pushing slowly northward and the Legations were already advising their nationals to leave Peking. Efforts were made to get as many of the women and children as possible to go to Dairen, Japan, or Manila.

A RAID ON THE SOVIET EMBASSY

Suddenly the situation was completely changed by a dramatic raid by Chang Tso-lin's soldiers on the premises of the Russian Dal Bank, next to the Soviet Embassy. As Chinese soldiers are not allowed to enter the Legation Quarter, the raid was made with the permission of the Diplomatic Body. Although they had agreed to allow the soldiers to search only the Dal Bank, they went much further and ransacked the office of the Military Attaché. The diplomats protested, of course, but only formally. The raid took place at eleven o'clock in the morning. I happened to be at the National City Bank on the opposite side of the street and witnessed the entire proceeding. It was most dramatic and totally unexpected by the Russians.

Until six o'clock that evening the searching proceeded. Many Chinese and Russian propagandists were unceremoniously hauled out from their hiding-places and hurried off to jail. One man attempted to burn various important documents, but the fire was extinguished before many had been consumed. Even in his wildest dreams, Chang Tso-lin could hardly have believed that his raid would produce such important results. Evidently the propagandists had depended upon the diplomatic immunity of the Embassy and had used it as a central clearing-house from which operations were conducted in various parts of the world. Most incriminating documents were found. Few people realize that raids which subsequently took place in London, Paris and in Argentina were made upon information obtained at the Soviet Embassy in Peking!

Chang Tso-lin then set to work systematically to rid north China of the propagandists. Those Chinese who were caught in the Embassy raid were slowly strangled. Search parties were busy day and night rounding up the others whose identity had been disclosed by the captured papers. Hardly a day passed that one or more persons were not executed at the public ground opposite the Temple of Heaven. The place has the appropriate name of "The Heaven's Bridge." The propagandists fled from north China like rats deserting

a sinking ship. In a very few days Peking and its environs had lost its apprehension and settled down into quite a normal existence. Heavy fighting was going on, but it was still some distance from Peking, and the raid had so disrupted the system of the Southerners that Chang Tso-lin made some progress in driving them back. Finally, however, they recovered from the blow and again began to advance slowly northward.

IMPOSSIBILITY OF A 1927 EXPEDITION

The prospect for continuing our explorations in Mongolia could not have been blacker. Even had I been able to get the Expedition away from Peking, the American Minister would have prohibited us from leaving. Hardly a foreigner was left in China away from the seaports. Still, it was most disheartening to face another season of inactivity.

Granger, Olsen and Nelson sailed for America. Only McKenzie Young remained with me at the headquarters. We proceeded to liquidate certain effects of the Expedition, put others in a place of comparative safety, and reduce current expenses to the minimum. I decided to stay in Peking during the winter, hoping that one of those sudden changes that so frequently occur in Chinese politics would give some encouragement for an expedition in 1928.

THE SVEN HEDIN EXPEDITION

When I arrived in Peking, I found Dr. Sven Hedin, the famous Swedish explorer. He had come during the winter with a large staff of Swedish and German scientists and comprehensive plans for an expedition by air across central Asia. His work was largely financed by the Luft Hansa, a German concern, and was to include other sciences besides those relating to air navigation. He had met most unexpected opposition in Peking. An anti-foreign group which called themselves "The Society for the Preservation of Cultural Objects" had launched a bitter newspaper attack not only upon Doctor Hedin but upon all foreign expeditions. They claimed that China was being "robbed of priceless treasures" even when such "robbery" was limited to meteorological observations, geologic specimens and fossils. The Society was an entirely unofficial organization, but by false publicity it had succeeded in arousing such popular indignation that the government authorities dared not ignore its activities. After months of delay Doctor Hedin was forced to abandon his program of aëroplane exploration. He endeavored to save something out of the wreck by proceeding by camel and carrying on other forms of scientific investigation. Even then the Cultural Society insisted that a Chinese be appointed as co-director of the expedition and that all of the collections be given to the Chinese. In addition he was forced to accept ten Chinese students and "professors" as members of his party.

Rather than abandon his entire expedition, Doctor Hedin at last agreed to these extraordinary demands. While I thoroughly understood and sympathized with Doctor Hedin's position, it was obvious that his acceptance of such preposterous conditions would make it extremely difficult for other expeditions to carry on their work. My predictions were amply justified by future events. By the time Doctor Hedin was allowed to leave, conditions in the interior had improved sufficiently to make it safe to go with a large party such as his. It was then much too late for our expedition to start, since our working period was of necessity limited to the summer months.

PLANS FOR 1928

I spent the entire winter in Peking, watching events most closely. The war had developed into a stalemate and neither side was making important gains. It became quite evident that the real test of strength would come in the next summer, 1928. By the end of January I had made up my mind that we would make a final effort to get into Mongolia. I hoped that we should be able to slip out during the interval of comparative quiet between the end of the winter and the beginning of the summer campaigns. If we were caught again I determined to abandon the work. After cabling the Museum to have all the staff reach Peking not later than April 14, I set about collecting a new caravan, for I had sold our camels to Doctor Hedin. It was extremely difficult to buy camels because so many had been confiscated by the soldiers. Reverend Joel Eriksson, of the Swedish Mission at Hatt-in-Sumu, one hundred and thirty-five miles north of Kalgan, consented to act as my agent. Slowly he collected the one hundred and twenty-five camels necessary for our work.

BRIGANDAGE BEYOND KALGAN

Conditions on the Mongolian plateau at that time were extremely bad. Because of the unceasing warfare, virtually all business with Mongolia had been suspended for nearly two years. The entire region swarmed with bandits who raided right up to the walls of Kalgan. If an automobile or a caravan left the city it was robbed before it had gone fifty miles. The brigands held complete sway over all the cultivated region through which it was necessary to pass before one could reach the desert.

Eventually conditions became so bad that something had to be done. Not only were the merchants being ruined, but the bandits themselves were dying of starvation. There was no one to rob and the food in the border villages had all been consumed. As usual in China, the Chamber of Commerce in Kalgan took matters into their own hands and entered into negotiations with the brigands. The local government officials agreed that certain "*liaison* bandits" would be allowed to enter Kalgan and make their own private

arrangements with the caravan owners. Those caravans that paid five dollars a camel would be allowed to pass through the brigand area unmolested. Each motor car was to pay one hundred dollars. This form of "protection" is common in China and works smoothly enough as a rule. Early in February, after the arrangements had been completed, thirteen thousand camels left Kalgan at one time bound for Urga, Uliassutai, Kobdo and Hami.

EXORBITANT TAXES AND GRAFT

Meanwhile McKenzie Young and I collected supplies and equipment in Peking and transported them to Kalgan. We were forced to pay exorbitant transit duties on everything. Taxes were levied when our stuff left Peking; again when it was half-way to Kalgan; again when entering and still again before leaving Kalgan. Such taxes amounted to nearly three hundred dollars on each motor car alone. We had eight cars. All of them had been in and out of Peking and Kalgan several times and should have been exempt; we had the former tax receipts, but that made not the slightest difference. If the taxes were not paid in full, the cars could not move. The new officials who had obtained posts did not expect to hold them long, since everyone felt that a change in the political situation would take place during the summer. Therefore they were all trying to make as much money as possible out of their positions while they could. In addition to the so-called official taxes, nearly all the offices swarmed with individuals who would detain our equipment or make other trouble unless they were given a generous amount of "squeeze." It cost us about ten thousand dollars in taxes and squeeze to get our cars, camels, food and equipment out of Peking, and into and out of Kalgan.

COÖPERATION BY THE PRESS

Before we started to ship our equipment, the American Minister, Honorable J. V. A. MacMurray, had called upon the Dictator, Marshal Chang Tso-lin, and informed him of our desire to continue work in Mongolia. The Marshal had given his consent and I had gone to Kalgan to make arrangements with the local authorities as in the past. I found them agreeable and they gave the necessary permits for us to leave for Mongolia. I knew, however, that it was imperative to have no publicity about our departure, because it might stir into action the unofficial Cultural Society which had caused Hedin so much difficulty the previous year. To this end the foreign correspondents of various world newspapers and those of the local press acted with the greatest kindness. They all agreed to make no mention of the Expedition until after our departure, and kept their promises to the letter.

AGREEMENT WITH THE BRIGAND REPRESENTATIVE

Our caravan reached Kalgan early in March, with five thousand other camels just down from Urga. Accompanying them was a bandit "liaison officer." A few years before he had been a respectable landlord of one of the motor inns on the Urga trail. I knew him well and knew that now he was a head brigand. What is more, he knew that I knew it. But it would have made him "lose face" to admit the fact. Therefore, we were introduced as though we had never seen each other. While he remained in Kalgan he posed as a "general" who could arrange protection for our caravan through his "soldiers." Half an hour of tea-drinking and extraneous conversation ensued before we got around to business. He suggested the customary fee of five dollars a camel. I offered one dollar. He knew that our boxes contained nothing that his brigands could use or sell, and eventually we settled on half the usual rate.

Just before he left he brought up the matter of the one-hundred-dollar fee for each of our motor cars which would go out some weeks after the camels had left. I became very vague at that. We were uncertain when we would leave—how many cars there would be—I would get in touch with him later! But I did mention that after all we hardly needed protection for we would have thirty men on the cars, all would have rifles and, moreover, there would be a machine-gun which could shoot two hundred bullets a minute. I did not make a definite statement. That would have sounded too much like a threat, knowing what he knew I knew. I just murmured it as though I were considering the matter aloud. But he understood, and talk of "protection" money for the cars was dropped forthwith. When the camels left, I instructed Tserin, who had been promoted to caravan leader, to leave gasoline at Hatt-in-Sumu and to await us at the Shara Murun River.

STAFF OF THE 1928 EXPEDITION

The scientific staff arrived in a body the third of April. Several of them were new men. As geologist we had Dr. L. Erskine Spock, of Columbia University, one of Doctor Berkey's former students. Not only was Doctor Spock familiar with Doctor Berkey's methods of work, but he had with him Volume II, "The Geology of Mongolia," by Berkey and Morris, the first of the final reports to reach the press. Mr. Nelson's place as archæologist was taken by Mr. Alonzo W. Pond of the Logan Museum, Beloit College, Beloit, Wisconsin. Mr. Pond had had extensive field experience in Europe and Africa, and was well qualified to assume the difficult work in Mongolia.

As his assistant in palæontology, Doctor Granger had brought Mr. Albert Thomson, for many years an expert preparator in the Department of Vertebrate Palæontology of the American Museum, and a man of long and

varied field experience. Mr. J. B. Shackelford, photographer, veteran of our previous expeditions, arrived with the others.

In Peking I had replaced Doctor Loucks, surgeon, and Norman Lovell, assistant in motor transport, both of whom were out of the country, with two new men. Dr. J. A. Perez, U. S. Navy Medical Corps, was kindly loaned to the Expedition by the Honorable Curtis D. Wilbur, Secretary of the Navy, and Brigadier-General Smedley D. Butler, Commanding the Third Brigade of the U. S. Marine Corps, then stationed in Tientsin. Mr. G. Horvath, who was employed as mechanical expert by the Frazar, Federal Company of Tientsin, agents for Dodge Brothers motor cars, joined the Expedition to fill Lovell's place. Captain W. P. T. Hill, who since 1926 had been stationed in Peking with the Legation Guard, furnished by the U. S. Marine Corps, was again detailed by the Secretary of the Navy and the Major-General Commandant of the Marine Corps to act as topographer of the Expedition. The foreign staff numbered ten men. The native personnel consisted of six technical assistants, three cooks, two camp boys, and two chauffeurs, all Chinese. Of Mongols, there were three interpreters who went with the motor party, and twelve camel men. Thus the Expedition numbered thirty-eight individuals.

OBJECTIVES FOR 1928

Our plan was to go first to Shara Murun where work could be continued in the previously discovered fossil beds. In the meantime we would make a further exploration to the west, trying to discover a new route which would lead us to Chinese Turkestan without going into Outer Mongolia. Our particular objective was the great low basin which we had tried twice to reach by crossing the Altai Mountains.

CHAPTER XXXII

START OF THE 1928 EXPEDITION

DIPLOMATIC INFLUENCE

On April 12, the staff, with the exception of Captain Hill and myself, left for Kalgan. The members of the staff established themselves in the British-American Tobacco Company house, which had been put at our disposal through the kindness of Mr. Hartigan, the manager. Two days later, the American Minister, Mr. J. V. A. MacMurray, his wife and sister, and Mr. Lewis Clark of the American Legation went up with Captain Hill and myself. The Minister and his party wished to see the Expedition start and to accompany us for a short distance beyond Kalgan. The Minister's presence was of much help to us in Kalgan. Not only did the officials hurry through the final passports, but we were relieved from paying the road tax, which for our eight cars would have been a considerable amount.

When we left on the morning of April 16, the Kalgan authorities provided an escort of fifty cavalry to accompany us to the top of the pass. There was little danger for that distance, but they were taking no chances where an Envoy Extraordinary and Minister Plenipotentiary was concerned. After a few miles of driving sedately in the dust cloud behind the cavalry, we assumed that the amenities had been observed. The horsemen were left to await the Minister's return, but at every corner of the road groups of soldiers popped out unexpectedly to present arms. This went on all the way to the village of Changpeh, where the Minister's party left us. We spent the night there in a Chinese inn. Trouble might be expected on our next day's run through the bandit country, and we wanted daylight for all of it.

A BANDIT RUSE THAT FAILED

A hard rain began early the next morning and continued all day, so that we could not start. I served out the rifles and ammunition for all of the men, and we planned exactly what to do in case of attack. The commander of the troops at Changpeh told us that there were three hundred brigands in the

THE EXPEDITION IN CAMP AT NIGHT LISTENING TO THE VICTROLA.
Left to right: Hill, Pond, Thomson, Andrews, Granger, Horvath, Young, Spock, Perez.

PLATE LXXXIV.

A. A HALT FOR LUNCHEON ON THE WAY TO ULA USU, 1928.

B. CAR BADLY MIRED, 1928.

region of Chap Ser, about sixty miles from Changpeh, and that probably they would give us trouble. He also remarked that his farthest outposts were twenty miles from the village, and that any armed man beyond that point was a bandit. Nevertheless, we did not worry at this rather grim information, because under ordinary circumstances twenty Chinese brigands to one foreigner are about the correct odds. All of the bandits are soldier deserters. Not only are they badly armed, but few Chinese know how to shoot, and their courage evaporates very quickly when they are opposed by a determined white man. The commander told us that a week before our arrival his troops had had a battle with about one thousand brigands. Since many of his soldiers did not return, he surmised that they themselves had become robbers.

The next morning was bright, with a strong, cold wind. We left the inn at half-past six. American flags and that of the New York Explorers' Club flew from every car, and each man held a rifle in his hand. I felt certain that even three hundred bandits would hesitate before attacking us in the open. For the first fifty miles we saw no armed men. The villages were almost deserted, the fields untilled, and few farmers appeared upon the road. Impressive indications of how the bandits had devastated the countryside! Not far beyond a small river, called the "Black Water," we approached eight well-dressed and heavily armed mounted soldiers. As they were much outside the twenty-mile limit set by the Changpeh commander, they must certainly be bandits and I told our men to keep them covered. They made no move to touch their weapons, but signaled that they wished us to stop. Keeping my revolver in hand I let them draw up alongside the car.

The spokesman said that they were part of a guard detailed by the Changpeh commander to escort us through the brigand area. Of course, I knew that was a lie. He further remarked that he would like us to stop for tea in the next village, about ten miles up the road. The place where he so cordially invited us to have tea was a fortified village, where most of the robberies had taken place and about which we had been particularly warned. At my request for his credentials, the "soldier" produced a letter written in Chinese, purporting to be from the Changpeh commander, saying that eight cars were to arrive with a party of Americans and to give them protection. The letter had no "chop" or seal, without which no communications are official in China. The ruse was obvious. The bandits, being afraid to attack us in the open, hoped to entice us to stop in the village. While we were having tea we would have found ourselves covered by rifles and either have been killed at once or held for ransom.

I told the brigands to leave at the double quick or we would shoot them where they stood. They lost no time in galloping away. When we reached the village we found that it had been converted into a real fortress. Deep

ditches on either side of the road prevented a car from turning off, and two diagonal, loopholed walls covered all approaches. Many unarmed men were ostentatiously lolling about the entrance as our motors roared through. They seemed considerably surprised when we did not stop. Some time later we learned the sequel to the story. A wounded bandit came to Hatt-in-Sumu for treatment. He told Mr. Eriksson that the brigands were very angry because we had escaped their trap, and were preparing a hot reception for us upon our return.

At our village, Bato and the various families welcomed us with joy. Shackelford had brought many illustrated papers, showing photographs of these same people taken on the previous trip. The women, particularly, were thrilled, and handled the papers as though they were made of gold leaf. By the time we reached Hatt-in-Sumu, a violent gale was blowing and we welcomed the shelter of our tents.

THE SWEDISH MISSION OF MR. ERIKSSON

In 1926 the Swedish mission station at Hallong Ossu was moved to Hatt-in-Sumu. It had been at Hallong Ossu for some fifteen years. When it was established, Chinese cultivation had not reached the region and the missionaries found Mongols living all about them. As years went by the Chinese farmers pushed their fields farther and farther into the grasslands, driving the Mongols before them to new pasturage. Since their work was essentially among the Mongols, the missionaries themselves had to move in order to maintain contact with their people. Mr. Eriksson had purchased an abandoned temple, Hatt-in-Sumu, as the site of their new home. They lived in the temple until a new mud house had been erected. In 1930 there were seven buildings, including a dispensary and operating room, for Mr. Eriksson's work is largely along medical lines. His medical training is sufficient to qualify him to handle ordinary diseases and accidents, and he has done an enormous amount of good among the Mongols.

The mission station nestles close to the base of low granite hills, commanding a view of the rolling grasslands for many miles to the east. It is a charming spot and I cannot wonder that the Erikssons love it. Mr. Eriksson is an exceptional man. Alert and keen, able to turn his hand to almost any kind of work, he tells me that he is perfectly happy and hopes to live the remainder of his life in Mongolia. When he passes, the Mongols will have lost a true friend. They appreciate little enough what he does for them. Eriksson is always ready to drive long distances in his little motor car to attend either the poorest herder or one of the reigning princes. He even keeps on excellent terms with the lama doctors from neighboring temples, and treats with sympathetic understanding the superstitions of his patients. The reli-

gious side of his work is difficult. After fifteen years the mission numbers only about forty converts, but the good he has done is measured in infinitely greater terms. There are two or three other mission stations, all Swedish, in the region.

MONGOL DISEASES AND MEDICINES

Mr. Eriksson tells me that the most prevalent illnesses among the Mongols of his region are venereal diseases. He says that about ninety per cent. of all men and women who have come under his observation have, or have had, syphilis or gonorrhea. This is due, of course, to the promiscuous habits of both sexes. Often, however, he finds healthy children from parents, one or both of whom are afflicted with syphilis. The lama doctors use a root called "tu-fil," which he thinks is a species of sarsaparilla, in treating syphilis. The patient is given very little to eat, no meat of any sort, and only a little soup, and is not allowed to leave the tent for several weeks. The Mongol name for syphilis is "the new time disease," but none venture to say how old it is or from whence it came. Doubtless syphilis is often contracted from pipes, which are passed from mouth to mouth, but the lamas are by far the most potent agents in its widespread distribution.

Mr. Eriksson says that, after venereal disease, scabies is certainly the most common complaint. Because of the common lack of cleanliness, almost every sort of skin disease that "flesh is heir to" appears at some time. Muscular rheumatism is almost universal, due to exposure, cold yurts, et cetera. Eye troubles are very prevalent, such as conjunctivitis, cornea sores and ulcers. These are engendered by sandstorms out-of-doors and constant smoke within the yurt.

Tuberculosis is decidedly uncommon. It is doubtless prevented by continual sunlight and the open-air life. Indigestion is a common complaint, and bronchitis in winter is almost universal. Smallpox is prevented to a considerable extent by vaccination, which is given to every child from four to ten years old by the lama doctors. They use the Turkish method. Crusts from a newly recovered patient are gathered and ground up with pearls and other substances which are supposed to weaken the germs. The more precious the dilutant the more effective the medicine, they believe. This powder is blown into the mucous membrane of the nose of the child. The patient is thus given a regular case of smallpox, which may be light or severe. Often the children die. There are certain lama doctors who seem to have very few deaths to their discredit, and naturally these are most popular. After vaccination the child is confined in the yurt, and the parents try to prevent it from pulling off the crusts. Frequently an entire village will be vaccinated at one time.

Typhoid fever is often seen, but is not really prevalent, and typhus is rare. The lamas recognize infectious diseases and try to keep such patients segregated. Scurvy appears only in the spring, but at that time it is very common, because the Mongols then have no fresh meat or milk. They are living on meat killed the previous autumn and kept frozen during the winter. From the end of November to the beginning of June, the Mongols kill no stock, because the animals are all thin. Scurvy begins to develop in early April, but few people die of the disease. The natives are thoroughly familiar with its symptoms and know that almost any green vegetation will arrest its progress. Since nettles appear earlier than anything else, they eat quantities of this plant.

While we were at Shabarakh Usu and Kholobolchi Nor in 1925, Doctor Chaney obtained from lama doctors a list of plants which the Mongols use in their medicinal work. Many of the lamas were educated in Tibet, which accounts for the considerable number of Tibetan names applied to the remedies. Unless otherwise stated, the part of the plant used is boiled and the dose is taken in the form of the tea which results. I submitted this list to Dr. Bernard E. Read, Professor of Pharmacology, Peking Union Medical College, with the request that he indicate which of these plants have value in modern medicine. Doctor Read very kindly annotated the list, and said:

"Some of the plants, in fact practically all of them, occur in the materia medica of some ancient medical system but their scientific value is probably insignificant."

He further remarks that only two have any place in modern medicine. One of these is rhubarb, *Rheum undulatum*, a well-known purgative; the other is ephedra, *Ephedra equisetina*, which contains ephedrine, very good for asthma and respiratory disorders. Of pepper-weed, *Ruta*, he says: "*Ruta graveoleus* used to be official and is occasionally used in hysteria." Of mountain rose, *Rosa acicularis:* "Rose preparations are known the world over for their mild aromatic and astringent value."

It is very surprising to me that the Mongols have not found more plants that really are efficacious in disease.

LIST OF MEDICINAL PLANTS

Scientific Name	Common Name	Native Name	Use
Astragalus brevifolius	Dwarf Rattle-weed	Ortouze	For burns.
	Camel's Tail Mint	Temen-sul	Ashes for burns and wounds.
Plantago major	Canyon Plantain	Tabal-sala	Leaves made into plaster for "Siberian sore."
Ranunculus plantanifolius	Hummock Buttercup	*Bánza-dó	For throat.
Potentilla sp.	Five-finger	Ay	Smelled for colds.
	Red Broom-rape	Goyo (*Mak)	For catarrh and headache.
Scrophularia incisa	Figwort	*Barood	Flowers for throat.
Allium fistulosum	Giant Onion	Zerlyk-sonion	For loss of appetite.
Rheum undulatum	Rhubarb	Geschuna	Cathartic.

* Tibetan.

Artemisia sp.	Sage	Khara-schabaga	Leaves for constipation.
Mulgedium tataricum		*Ruda	Root for stomach.
Arnebia guttata	Bloodroot	*Mugtse	Roots for blood diseases.
Clematis orientalis	Clematis	*Mynjing-serba	For heart disease.
Ephedra equisetina	Ephedra	Dzérgene	Stem for rheumatism.
Dracocephalum moldavica	Blue Mint	*Ajig-tzrungo	For fever.
Astragalus lupulinus var. *laguroides*	Rattle-weed	Gange-djun	Flowers for fever.
Crepis tenuifolia	Hawksbeard	Tzetz-serba	Flowers dried for headache and high pulse.
Hedysarum fruticosum var. *mongolicum*	Henna Pea	*Leadere	Root for fever.
Ruta sahurica	Pepper-weed	*Tetz-serba	For nerves.
Rosa acicularis	Mountain Rose	Nokhoin-khuschoo	Dried berry mixed with other ingredients for smallpox.
Carex sp.	Mountain Sedge	Schyrkhe	"Medicine."
	Dwarf Mustard	Scharkhyras	Leaves for stock worms.
	Blue Parasite	Zerlykgoyo	Stalk dried and burned to produce smoke as disinfectant for castrating animals.

* Tibetan.

A VISIT TO PRINCE WEST SUNIT

Since I wanted to pasture my camels in West Sunit Wang's region the coming winter, Mr. Eriksson thought it wise for me to call upon the prince. He lives about forty miles to the northwest of Hatt-in-Sumu, and we went there by car over the beautiful rolling grasslands. The "false spring" which was just beginning gave one the impression that summer had come in earnest, but we knew that long days of cold and wind would soon return. The air was so warm that we sat in the car with no coats, luxuriating in the sunlight.

The prince's establishment was a series of brick houses of Chinese architecture, surrounded by a wall. Several spacious yurts were pitched near-by, which, I was told, were the quarters of his women. He himself is about twenty-six years old, more Manchu than Mongol in appearance, and has a rather stupid, vacant face. Nevertheless, I believe that he maintains strict discipline in his province and at times takes a high hand even with the Chinese authorities in Kalgan. He has one thousand Mongol soldiers whom he uses to patrol his territory. He is one of the most powerful princes of Inner Mongolia, and maintains much of the dignity and display of his ancestors when he moves abroad. Still, he realizes that, with the Outer Mongols on the north and the Chinese to the south, he may be robbed of his possessions at any moment. He received us pleasantly enough, after a long wait, and readily agreed to allow me to pasture my camels in his province whenever I wished to do so. I gave him a Stanley steel thermos bottle and a dozen phonograph records as presents.

DUNE DWELLER ARTIFACTS NEAR HATT-IN-SUMU

When we returned to Hatt-in-Sumu, Pond showed us a number of Dune Dweller artifacts which he had found on a ridge only a short distance from

the mission station. Subsequently we discovered that they were abundant all through the grasslands to the east.

HATT-IN-SUMU TO CHIMNEY BUTTE

On Friday, April 20, 1928, we left the mission station of Hatt-in-Sumu at six o'clock in the morning of a beautiful day. The air was so exhilarating and the sun so bright that we sang like schoolboys as the miles of plain vanished under the car wheels. The trail was our former route of 1925, and as Roberts had already mapped it, there was no delay for topographic work. We found the trail dry and exceedingly good; also, our fleet consisted this year only of Dodge Brothers cars, and we were not hampered with the heavier trucks, which often broke through the crust, whereas the lighter automobiles passed over it easily.

The tiffin hour found us fifty miles from Hatt-in-Sumu, in a most picturesque spot among some giant boulders. We had done so well in the morning that I began to have hopes of reaching Shara Murun before dark, even though I knew that there were two stream courses ahead, which in former years had bothered us a good deal. We reached and passed the bad places with hardly a pause, for the stream beds were perfectly dry, although there was plenty of water in the wells. We saw a good many grassland gazelles and some bustards; also four large Mongol caravans upon the trail. This was very different from former years; then almost all the caravans had been Chinese. When we reached the main Sair Usu trail, dead camels were to be seen every few miles. Since several of the carcasses were fresh, I feared that they might be some of our caravan. At six-thirty in the afternoon, when the escarpment of Shara Murun had begun to show as a purple line backed by the dull gold of sunset, we saw the camels of a great caravan grazing in the distance. Just beyond them a blue tent floated like a huge bird in the mirage; then it settled definitely to earth and the American flag streamed out from its peak. Our Mongols greeted us with joyous shouts. They had waited here, seven miles from the lamasery, because the feed was better. The camels were fit, the gasoline was not leaking overmuch, and generally all was well. We camped that night beside them. For the first time I felt that the Expedition was really under way again after the two years' struggle with war and brigands, officials and diplomacy. The Gobi lay in front of us; our only opponents were the natural forces of the desert.

It was eight o'clock before we left camp the following morning. Until the sun was high we were comfortable in our fur coats and sweaters, shedding them in layers every hour. The Shara Murun River was dry, and we ran up the broad valley on a trail like a race-track. Gazelles were everywhere. We saw one herd in which both species were feeding together—a rare occurrence.

The Tukhum temple lay white and dazzling four miles from Viper Camp, but we stopped only long enough to greet the Mongols. By ten o'clock we had reached Viper Camp and swung north on the plain to Chimney Butte, where, in 1925, a fossil quarry had been discovered. The old motor tracks were still visible as lighter green streaks, where the snow and rain had settled in the depressions and given them a little more moisture than the surrounding plain.

WORK AT CHIMNEY BUTTE

Camp was pitched on a promontory close to the edge of the escarpment. Below us on three sides lay a gigantic relief map of painted badlands, gray and red buttes, ravines and canyons which had been carved out of the table-land by wind and water. In a narrow valley to the south of our promontory were two yurts surrounded by a rampart of argul bricks—a welcome sight, for it solved the fuel problem during our stay.

Shackelford arranged the tent locations with a view to a panoramic photograph, and we proceeded to make ourselves snug for a considerable stay. The men sorted out their various equipment, for this was to be the beginning of actual field work. By mid-afternoon Granger and Thomson, with the Chinese fossil collectors, were in the badlands, and before they returned at six o'clock every man had located a promising specimen. Granger discovered a beautifully preserved jaw of a probably new genus of carnivore, while "Buckshot" and Liu opened a quarry which they had discovered in 1925.

This quarry proved to be a most interesting spot. It had been the bed of an ancient stream, which ran upon the surface during Eocene times. The course could be easily traced where it was exposed in cross-section. At the bottom lay the heaviest gravel, above it a finer layer, and still higher the lightest sediment. Evidently it had been a very gently flowing stream, and thousands of animals had fallen into it and died. Parts of their skeletons had been buried and preserved in the fine sand and silt. In some places they formed a breccia of bones, almost like a heap of "jackstraws." Birds, fish, turtles, rodents, carnivores and other mammals lay in an indescribable tangle. *Chalicothere* jaws were abundant. It required the highest skill to separate one from the other. It was a most important deposit, for we obtained a more complete representation of the small fauna of this phase of the Eocene than had been discovered in any other place. It is seldom that the delicate, hollow bones of birds are preserved, but the collectors found many identifiable skeletal parts at this spot.

The day after our arrival at Chimney Butte, Granger, Spock and Pond went to Baron Sog to check up on the relation of the exposures there to those

at Chimney Butte. At tiffin the caravan arrived, and the afternoon was spent in photographing, for it was a beautiful day. It is not easy to "stage-direct" one hundred and twenty-five camels, but Shackelford accomplished it splendidly.

VICTROLA AND RADIO

That night we had our first concert with the new victrola. The "radiola" attachment gave us as good music as we could have heard in any theater of New York. We had a radio also, which proved to be useful to us. As a rule I am not a believer in radio for an expedition such as ours. I find that the entire personnel is happier, more contented, and works better, if there is absolutely no news from the outside world. Most of the men have wives and families. We leave them in good care, confident that all will be well, but suppose that a man gets word, when we are a thousand miles out in the desert, that his wife or children are dangerously ill! It is impossible to return, or, if he could, not for weeks or months. Anxiety would ruin his work. Better that he knew nothing, since he could be of no assistance. But 1928 was somewhat different, since political conditions in China were extremely uncertain; moreover, we needed the correct time for longitude observations. Our set was for receiving only. I arranged with the American Legation in Peking to send us any really important news, and with the U. S. Navy to transmit time signals on a short wave from Cavite, Philippine Islands, each night.

The Mongols, of course, thought it a miracle when we let them listen with the head phones to broadcasting from the theaters of Vladivostok and Khabarovsk in Siberia. It seemed like a miracle to me, too, out there in the desert where one has time really to think. We could even hear the sound of feet on the platform and the talking of the audience between acts. Horvath spoke Russian, and sometimes he got bits of world news, but most of it was propaganda and gave us very little information.

It always thrilled me when the time signals came in, for that was something direct and personal. I knew the naval station in Cavite, Philippine Islands. The moon shining across the waters of Manila Bay on palm trees and flowers; the stifling heat; the operator dressed in white at his keyboard. At ten minutes to ten: "Here goes for those fellows up in the Gobi Desert." Out into the night he sent the warning dots and dashes, followed by the signal at precisely ten o'clock. I wondered if he ever tried to picture us as we received his message: The long semicircle of blue tents; the restless mass of kneeling camels; men muffled in fur-lined coats; the grim reaches of the soundless desert. All under the same moon that looked down upon him in his tropic garden!

A SPELL OF BAD WEATHER

The weather, since we left Kalgan, had been as perfect as only Mongolian weather can be, but we expected a change any day. It came on April 24, somewhat earlier than usual. All during the night the wind raged, filling our tents with dust and sand so that it was impossible to sleep and difficult to breathe. About seven o'clock the gale abated somewhat and we were able to go down into the badlands. Doctor Perez found a very fine titanothere jaw and I discovered a rhinoceros skull in bad condition. Thomson contributed a large land tortoise, *Testudo*, to the day's collection. The quarry was so rich that Granger set all the Chinese collectors at work along the face of the bluff. The deeper they went into the sediments, the more interesting were the specimens exposed. Turtles and fish were very abundant, as well as small and large carnivores, and small ungulates such as *Lophiodon*. The wind died out in the late afternoon, giving us a quiet evening, but a fresh gale raged the next morning, confining us all to the tents again. Despite the gale, the men went into the badlands in the afternoon, and Young discovered a superb titanothere skull of a new type.

VAGUE NEWS FROM THE SVEN HEDIN EXPEDITION

Now that the work was well under way, I was anxious to make our proposed exploration trip to the west. Doctor Hedin's expedition had gone through the region which we had superficially explored in September, 1925, and followed the ancient caravan trail which leads to Chinese Turkestan. I hoped to find a new route, which would enable us to stay north of Hedin's traverse and still keep within Inner Mongolia. We could not cross the frontier, even for a short distance, without the risk of a fight with the border guards. Although Hedin's work was largely meteorological and quite different from ours, still in some respects it would overlap, and I did not wish to follow in his footsteps. No direct word from him had been received since his departure the year before, but vague reports indicated that his expedition had had a very hard time in a frightful desert; moreover, in spite of the grand promises made to him by the Chinese Government and the Cultural Society, the party had been detained for months at the frontier of Chinese Turkestan.

CHAPTER XXXIII

NEW FORMATIONS AT SHARA MURUN

AN EXPLORING TRIP WESTWARD FROM CHIMNEY BUTTE

For our exploration westward from Chimney Butte, I took two cars, and Young, Shackelford, Perez and Hill. We left on April 26, 1928, with food and gasoline for ten days. The caravan leader, Tserin, also accompanied us, in order that he might know where to take the camels if we found a practicable route. In going south and west, we investigated every trail which appeared to lead in the right direction. After several failures we eventually returned to the faint caravan path which we had followed in 1925. It led to a large obo on a prominent, well-exposed escarpment. An hour's search produced a quantity of fossil bones, which, although badly broken, convinced us that the deposit was worth investigating more carefully.

Turning off the old trail at the obo, we cut across country for about thirty miles on a smooth plain running southeast. No trails were discovered, but we found two wells near which were several yurts. Although we were in a vast basin of Tertiary sediments, it was undissected. Far off to the south there appeared to be exposures, and we came unexpectedly upon a small trail leading directly to them. The trail, a Mongol told us, continued to the great temple, Pailing Miao, which we had visited in 1925, and which Doctor Hedin had used as a base for assembling his camels in 1927. Following it, in 1928, we came into a rough exposure of the oldrock floor washed with light yellow sand. It was a desolate country with hardly a trace of vegetation, and very difficult to travel. Just before sundown we found a well in the midst of the sand-swept area, and camped for the night. Not far away were two small ponds, where Doctor Perez and I spent an hour shooting sand-grouse and ducks. Falcated and green-winged teals, mallards, shovelers, and burrow and ruddy sheldrakes were there in numbers when we arrived.

In the morning both cars were driven to the well for water. Apparently the surface was dry and hard, but as Young was driving away his car suddenly sank by the stern and came to rest with the engine pointing at the clouds. Under the six-inch crust was a mass of jelly-like mud. Experience has taught us that there is one thing to do in such cases, and only one: collect

stones, brush, bones, anything solid, and sink a foundation beside each rear wheel. Every push on the jack presses the foundation a little farther down, but eventually it will hold. In this particular instance it seemed as though we never should get the car out. All of us collected stones for four hours while Young worked frantically with the jack. Inch by inch he built a foundation up to ground level and laid a causeway in front. Then, with the other car towing and all hands pushing, out it came.

The morning had gone and we were all pretty well exhausted before the car was free. After tiffin we started south again on the faint trail toward Pailing Miao. Because of the rocky, sand-washed country, it was impossible to travel off the trail which the flat pads of camels' feet had stamped hard by years of use. Although the entire region seemed desolate, still a dozen Mongols had found enough vegetation in the bottom-lands to maintain a few sheep and goats. These people told us that there was a tax office and many Chinese soldiers at Pailing Miao, and that caravans always had difficulty there. As we did not wish to invite trouble we went only within sight of the temple, following the broad valley of a little stream. It was evident that the rough country of igneous rock ridges was impassable to the west, and we turned back, hoping to find a route on the northern side of the sand-swept area.

A day of hard traveling over the great erosion plane turned us back at every point, and we realized that we were enclosed by impassable country. The only possible route to the west was the one which Hedin had followed from Pailing Miao. In order to avoid the vast area of rough ridges, it would be necessary to go far to the north, across the border into Outer Mongolia where we were not allowed to go. We had been traveling by compass all day, and Captain Hill did a splendid bit of land navigation. He had taken directions at every twist or turn and brought us back to within a few yards of the spot we wished to reach, without a moment's hesitation. The basin we had explored is so vast that it is like navigating a dry sea. There were no trails or landmarks—only rolling billows of yellow hills, sometimes separated by areas so flat that there was hardly a break in the blue line where earth and sky met. It is a thinly grassed country, with little rainfall. This doubtless accounts for the fact that the edges of the basin are not dissected.

Far to the east the dim outlines of white, twin buttes were just visible. After traveling five miles toward them we came suddenly to the valley of the Shara Murun. Our two buttes lay well out in the depression itself, which at this point is very wide. The edge of the erosion plain on which we had been traveling breaks off into an almost perpendicular descent to the branches of the river three hundred feet below. After considerable search we discovered a steep slope down which the cars could reach the valley bottom, and there our tents were pitched. The escarpment was beautifully exposed, but two

hours' search gave us only a few fragments of fossil bone, from both the highest and lowest levels. The deposit was evidently stream work and was largely composed of very coarse gravel. We could not hope to find important specimens, as everything had been rolled and broken by the rapid stream action. Enormous quantities of gypsum were present in beautiful blocks and squares. Strangely enough, all the Mongolian deposits that contain gypsum are virtually unfossiliferous.

THE RETURN TO CHIMNEY BUTTE

At nine o'clock it began to rain and continued steadily until that time the next morning. To climb the steep softened slope to the erosion plain three hundred feet above us would have been impossible for less strongly built cars than ours. The entire country was obscured by a dense fog, and we could see not more than a hundred yards in any direction. Captain Hill set a compass course for the Baron Sog temple, but long before we reached the trail a violent wind swept away the gray mist. Every hour the gale increased, and when we reached camp at Chimney Butte we found all the men huddled in the tents. The last twenty miles had been a bitter fight against the bursts of sand and gravel, which cut our faces and made it almost impossible to drive. The windshield glass of both cars was so badly sand-blasted that eventually it had to be removed.

DECISION TO FOLLOW SVEN HEDIN'S ROUTE

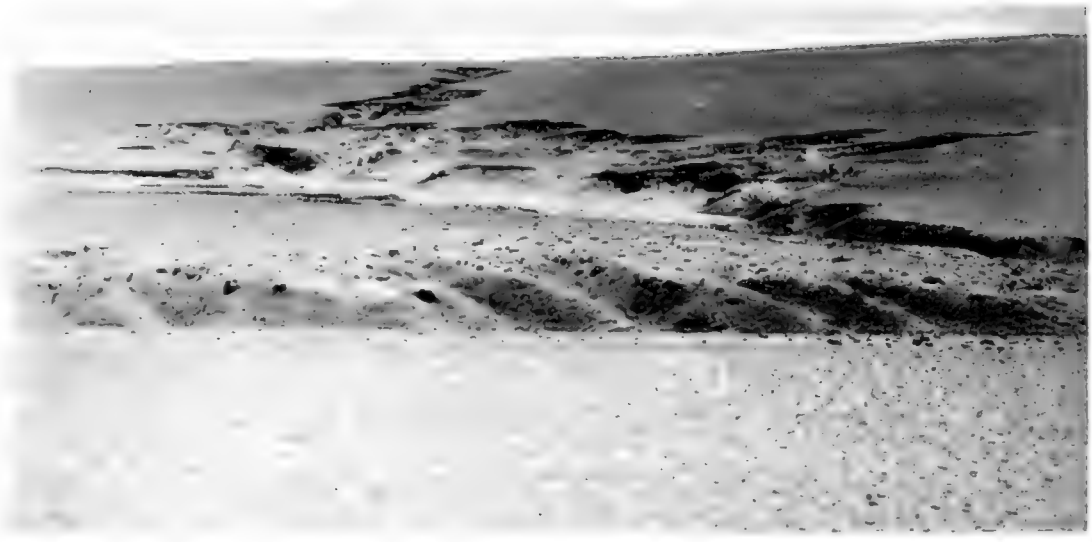
After a consultation I found the staff unanimous in the opinion that we should still make the western trip, even though it was necessary to follow the route taken by Sven Hedin's expedition. As I remarked in Chapter XXXII, his work varied considerably from ours, and he was not equipped to collect fossils to any extent. Moreover, with motors we could investigate the geology of the surrounding country more thoroughly than he could possibly do on the slow-moving camels. If we did not follow his route, further exploration in the west would have to be abandoned that year, for we could not cross into Outer Mongolia without weeks of negotiation for permits. I decided to start the camels immediately so that they could get well on the way before we ourselves left Chimney Butte, where the Expedition's staff was busy doing valuable work. From the caravan we removed food for three weeks and gasoline to carry the fleet five hundred miles. It was a most disagreeable day's work because the "false spring" had given place to cold sleet and fierce gales.

FURTHER WORK AT CHIMNEY BUTTE

Granger, Pond, Spock and Horvath made an exploration trip to the east across the Shara Murun. The following day they returned, having been

CAMP AT HEI NE HO, 1928.

PLATE LXXXVI.



A. THE BEGINNINGS OF BADLAND EROSION, URTYN OBO, 1928.

B. A DEEPLY ERODED CANYON, URTYN OBO, 1928.

driven back by the gale which blew incessantly. Nevertheless, they had discovered several large exposures which warranted careful investigation.

After the camels had left, there was nothing that we could do. The terrific wind made work in the fossil pits impossible; it had become very cold; the drifting sand and dust so filled our eyes that it was difficult to either read or write; muffled in fur coats we could only sit and listen to the roar of the gale and the slatting of the tents. The wind had continued with only short interruptions for more than a week. Everyone's nerves were on edge. During the intervals of comparative calm the men would work in the fossil fields for a few hours, but they could not endure the sharp particles of gravel which stung and cut their faces like shot. The quarry yielded some excellent fossils. As it must certainly have been the slack side of a small river where there was virtually no current, the specimens were well-preserved although separated into individual bones.

Thomson discovered a huge titanothere skull, which appears to represent an entirely new genus. Doctor Perez found a beautiful titanothere skeleton which, however, lacked the skull. As it would be a long job to remove it, and as it was valueless for exhibition without a skull, Granger decided to take only the legs. Pond had made a careful search of the surrounding country, but found no artifacts. Spock's geological work was ended. Therefore I decided to move camp to the new exposures on the east side of the Shara Murun, which Granger had discovered. We could be more sheltered there and it would quiet the nerves of all the men to investigate a new locality. The quarry at Chimney Butte was far from exhausted, but I hoped to give the palæontologists more time there in the autumn.

May 5 dawned as a beautiful day with no wind. What a relief it was to escape those continual blasts of sand and gravel! We packed our equipment hurriedly, struck the tents, and by nine o'clock were moving down the valley of the Shara Murun.

INJURY OF THE LEADER

As usual, Shackelford and I drove considerably in advance of the main fleet. Just after crossing the river I wounded an antelope and left the car to finish it with my 38-caliber revolver. There was a safety catch in the holster to keep the gun from dropping out. In releasing it my finger slipped off the catch, pressed the trigger, and the double action revolver exploded against my left leg. The heavy bullet struck me such a terrific blow that I went down as though felled by a sledge. While Shackelford ran back in the car for the surgeon, I discovered that the bullet had entered midway of the thigh on the left side, ranged downward and emerged below the knee, just nicking the distal end of the femur. After ascertaining that I could move my knee I felt almost

happy. Visions of a stiff leg for the rest of my life had been distinctly depressing. It was just such an event as we had always been expecting. During three years, with thirty-five to forty men in the field, we had had no serious accidents.

The rest of the party had passed us, but Shackelford drove back two miles for Doctor Perez. I told him to have Granger make camp and send back for me. When the doctor arrived he probed the long bullet course and put on a first-aid dressing; then I was carted to camp. The only view I had was the sky, but Granger said that we were in a shallow depression where the tents were somewhat protected from the wind.

In the afternoon Doctor Perez performed a very skillful operation, with the assistance of McKenzie Young. The wound was filled with bits of leather and cloth. The doctor had to cut along the bullet course for a considerable distance, to clean it thoroughly and sew up the torn muscle sheaths. Shu, our mess boy, stood by to hand things, but tears streamed down his face so that he could hardly see. The doctor had given me such a dose of morphine that the world looked bright and rosy; in fact, I was rather pleased with myself. But the next day, when the effects of the morphia had worn off and a sandstorm raged, black clouds seemed to have obscured my particular sun. I had a high fever, and with the rising sun a fresh gale began to blow from the north. Blasts of sand and gravel swept in under the tent in spite of everything that could be done. It was difficult to breathe. Because of the extraordinary precautions which the doctor had to take to avoid infection, the dressings were terrible. The tent was always filled with a yellow haze and during the necessary probing I suffered the tortures of crucifixion. Day after day the storms continued with hardly an hour's respite, but the dressings became less painful. No greater compliment can be paid Doctor Perez' skill than that, in spite of such impossible conditions, he kept the long bullet track absolutely free from infection. The wound began to heal perfectly and after ten days I was able to sit up during the intervals of comparative calm. My strength returned slowly, because of nerves worn by the unceasing sandstorms.

NEW FORMATIONS AND FOSSILS EAST OF THE SHARA MURUN

Meanwhile the work continued whenever the flying sand allowed our men to get out into the fossil fields. The deposits were rich. In the upper layer of yellow sands they found many *Baluchitherium* bones. Below a sharp unconformity, red and gray sediments contained quite a different fauna. Several skulls of a strange titanothere were found. We believed it to be allied to a smaller form discovered by Doctor Loucks in 1925, across the Shara Murun. Both these faunal horizons had been identified as probably new and had been

clearly demarked by Granger in 1925, on the west side of the Shara Murun valley, but he did not name them at that time. In 1929 they were named by Professor Osborn, as follows:

"Baron Sog Formation (Granger, 1925, 1928). Estimated thickness 35 feet, containing numerous new and undescribed baluchitheres . . . also undescribed entelodonts, *lophiodonts*, rhinocerotids, chalicotheres, et cetera. No record of titanotheres or embolotheres.

"Ulan Gochu Formation (Granger, 1925, 1928). Estimated thickness, minimum 132 feet, maximum 195 feet; containing embolotheres (type of *Embolotherium loucksii*, *E. andrewsi*, *E. grangeri*); also numerous undescribed embolotheres, as well as undescribed lophiodonts, rhinocerotids, artiodactyls, and carnivores. No baluchitheres thus far certainly recorded. A *sharp unconformity* between the Ulan Gochu and the overlying Baron Sog indicates that a long interval of geologic time elapsed between these two formations.

"The discovery of these two new formations reveals a survival of the titanotheres in Mongolia, after their extinction in America, and renders probable a new theoretic sequence of life zones. . . ."[1]

Professor Osborn considers the Baron Sog formation to be of Lower and Middle Oligocene, and the Ulan Gochu of Lower Oligocene, age. After some of the specimens reached the Museum for study, our field identification of the relationship between the smaller titanothere, found by Doctor Loucks in 1925, and the larger species discovered at Hospital Camp, proved to be correct. These skulls were so extraordinary in appearance that Granger felt certain that they represented a new phylum of titanotheres. Professor Osborn entirely agreed with that conclusion after examining two specimens, and the notes and photographs of others which had been retained for preparation in the Peking laboratory. He describes them as a new subfamily, in the following words:

"Embolotheriinæ, subfam. nov.

"One of the most surprising results of the Central Asiatic Expedition of the season of 1928, under the leadership of Roy Chapman Andrews and Walter Granger, was the discovery of an entirely new type of titanothere.

"The subfamily Embolotheriinæ, typified by the characters observed in three distinct species of *Embolotherium*, probably represents a purely Asiatic phylum, no members of which have thus far been discovered in North America; nor do the three species of *Embolotherium* herewith described from the Ulan Gochu formation seem to be related to the titanotheres discovered in the three older geologic formations previously described; they appear rather to

[1] Osborn, Henry Fairfield. 1929. "Embolotherium, gen. nov., of the Ulan Gochu, Mongolia," *Amer. Mus. Novitates*, No. 353, pp. 3–4; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 88, pp. 1–20, 1930.

represent immigrants into the central Gobi region, whose ancestors lived farther north in central Asia.

"In all, at least fourteen individual specimens of *Embolotherium* were found in the Ulan Gochu formation associated with the remains of lagomorphs and other rodents, carnivores, creodonts, hyænodonts, rhinocerotids, lophiodonts, and entelodonts characteristic of Lower and Middle Oligocene age."[1]

Professor Osborn gave the generic name *Embolotherium* (the "battering-ram-nosed beast") because he believes it probable that these animals used the great nasal projections for "battering, assaulting, attacking, and tossing." In describing *Embolotherium andrewsi* he remarks as follows:

"This superb animal constitutes one of the greatest surprises in the long palæontologic history of the titanotheres, because it differs from all previously known forms in the single rather than the paired structure of the bony horn and in its composition, which is clearly shown in the young individual (Amer. Mus. 26040, *Embolotherium grangeri*). Whereas in all other titanotheres the bony horn arises from the frontals, overlapping the nasals which are gradually reduced in size, in the present animals no frontal horn is known to have developed, but the nasals composed the entire anterior prominence, carrying forward on the lower surface the prolongation of the anterior nares. In brief, in all previously known titanotheres the frontals form the chief element in the horn and the nasals are reduced; in these embolotheres a complete change of function takes place, i. e., the nasals form the anterior bony horn. There was much speculation about this by the author and by Dr. W. K. Gregory and others until a photograph of the juvenile skull of *Embolotherium grangeri* reached the Museum, which appeared to settle the question.

"Such bony composition of the nasal horn is apparently characteristic of all three species, which, however, differ widely in the shape of the horn and in the abbreviation (*E. andrewsi*) or elongation (*E. grangeri*) of the premaxillary rostrum.

"In *Embolotherium andrewsi* we apparently have the most extreme stage of embolothere development, in which the single horn is the longest, widest, and most prominent and the premaxillaries are the smallest and most reduced. . . ."[2]

SEVERE WEATHER IN MID-MAY

On May 12 we had such a terrific sandstorm that no one could leave the tents. In addition, the temperature dropped many degrees and the wind was bitterly cold. Granger, Horvath, Hill and Shackelford were to make an exploration trip east as far as Iren Dabasu, and they left the next day even

[1] *Op. cit.*, p. 9.
[2] *Op. cit.*, p. 14.

though the wind was still blowing a full gale. A bright sun raised the temperature somewhat but still they needed their heavy fur coats. The following day was so cold that ice formed in the water buckets even in our tents, and the sandstorms continued with unabated violence. I think that no one who has not endured sandstorms can understand the torture to one's nerves, even when in good health. Physically weak, in continual pain and with fever, it became well-nigh unendurable to me. Often I had to bury my head in the blankets to keep from screaming. It seemed that something in my brain would crack unless there could be a rest from the smash and roar of the wind, the slatting of tents and the smothering blasts of gravel. But not a respite did we get. Sometimes there was an hour of comparative calm as the wind died with the sun, but before the afterglow had faded from the sky a new gale would burst upon us.

At last, on May 16, after a night of bitter cold, the sun lay soft and warm in the tent. Only a gentle breeze played over the green-tinged plains. I felt a surge of new strength and a great desire to be up and out. McKenzie Young had improvised a useful crutch out of sticks from Shackelford's portable dark room, and I could hobble about quite comfortably. At a spring three or four miles away, the sand-grouse came in hundreds and Young, the doctor and I drove there in the open car. Placed behind a high mound with a patch of water in front, I had excellent shooting at the birds which came in like bullets to circle about the stream. It was a veritable release from prison and I felt new life soaking into me from the sun-drenched earth.

EXPLORING TRIP TO IREN DABASU

About seven o'clock of the next evening, Granger and his party returned from the Iren Dabasu trip. It had been very successful. They had discovered that the sedimentary basin continues for more than a hundred miles to the northeast, and is well exposed in many places. Excellent prospects were offered for palæontological investigation. While they were at Iren Dabasu, Granger had spent a few hours at the Cretaceous beds where Johnson and Kaisen had worked for several weeks in 1923. He found a quantity of dinosaur eggshells and was convinced that the exposure represented an extensive nest site of the *Trachodon* and other dinosaurs.

WAR NEWS FROM CHINA

They also obtained unsatisfactory war news at the telegraph station. The Nationalists had taken Tehchow, only ninety miles from Tientsin, and were steadily pushing northward. There had been serious trouble in Tsinanfu, Shantung, which had been quelled by the Japanese with a loss of some two thousand Chinese lives. Colonel Holcomb, Commander of the U. S. Legation

Guard, reported Peking quiet. Only a few cars had ventured on the Urga road because of the bandits.

RELATIONS WITH LOCAL MONGOLS

The next day we were visited by a secretary of Durbet Wang, the prince of the district in which we were working. He had with him six heavily armed and picturesque Mongol soldiers. Subsequently we discovered that more than twenty others were concealed behind the surrounding hills within easy shooting distance of the tents. They were taking no chances of riding into an unfriendly camp. The secretary and one of the other officials spoke Chinese well. I received them in the mess tent, giving them tea and cigarettes. They asked about our work, and we showed them the fossils and explained that these beasts lived in Mongolia long, long ago. They seemed really interested and impressed. After being photographed and hearing a victrola concert, they rode away in good spirits.

On May 19, I drove over to Baron Sog lamasery to ask if we could leave the fossils until our return. They had refused in 1925, because of the "rinderpest," which the lamas had said was the result of our digging up fossil bones. The spirits were angry. After considerable talk with the head lama and a promise of fifty dollars, he agreed that the spirits might be pacified if we kept it a profound secret among ourselves.

CHAPTER XXXIV

WESTWARD INTO A LAND OF DESOLATION

THE REGION SOUTH OF BARON SOG MONASTERY

My strength had returned so rapidly during four or five days of fine weather that the doctor agreed to let us move camp. We planned to investigate the exposures near the big obo south of Baron Sog monastery. On Sunday, May 20, we broke camp. After depositing our fossils at the temple, we took on nineteen cases of gasoline, and five of our cars ran straight for the obo, across country. The other three were used by the topographers, who worked more slowly along the trail, mapping as they went. We skirted the edge of an enormous ancient lake basin, the Lybaghrin Nor, which is about twenty miles wide by sixty miles long. The obo is on one of the old shore escarpments which juts out in a long promontory. The basin to-day has only two ponds and a meandering stream, but obviously it must have contained a great quantity of water not very long ago. Probably during the last moist climatic cycle an extensive lake occupied a large part of it. In places the floor is as smooth as a pavement, but in the center an area of playa-tufts makes automobile travel difficult.

After tiffin, I drove up, with Shackelford, to photograph the obo. In addition to the usual conical pile of rocks, there is a well-built mud shrine. The whole is ornamented with bundles of poplar twigs from bushes near the stream, and hundreds of weather-worn silk scarfs (hatas); also wooden spears and other offerings. Although the exposures are splendid, none of the men discovered more than a few unimportant fragments of fossil bones. Pond found no artifacts whatever. It seems certain that there must have been camps of primitive human beings near such a large body of water, but they were probably well back on the ancient shore-lines. Indeed, later in the season Pond was guided by a Mongol to such a spot.

CHINESE CHAUFFEURS

We left the next morning in cloudy weather, and made but slow progress because of the topographers. Our route was that which we had traveled on

the western reconnaissance of 1925. In the late afternoon the clutch of a car driven by one of the Chinese chauffeurs broke, and we had to camp near a well of bad water. The Chinese had been "riding the clutch," that is, running with it only half let in. As a result, all of the plates had been worn beyond repair. It meant a long job for Young and Horvath to substitute new plates. No matter how great experience Chinese have as chauffeurs, they are all bad. As in so many other aspects of modern life, they lack judgment. Just as long as a car will continue to run, a Chinese will go on, blandly disregarding danger signals which to an intelligent driver signify trouble. When we reached Pailing Miao the next day, I told the chauffeur that he must leave us. After giving him ample money, I arranged with a Chinese caravan to transport him to the railroad at Kweihwating. Pond took over his car.

"LAND OF THE LARKS"

The stop at the camp where the clutch was repaired gave Spock an opportunity to examine the surrounding ridges. Some of them proved to be of Palæozoic limestone containing badly preserved plant fossils. Not more than five miles from our camp was the residence of Pailing Wang, prince of the district. The name means "Prince of Larks," and the entire Pailing Miao region is known as the "Land of the Larks." The Mongolian lark, which is certainly the most abundant bird both in the grasslands and on the desert, is highly prized by the Chinese. They are excellent singers, and mock the songs of other birds and the miao of a cat in a remarkable way. In this region, as elsewhere in the grasslands, Chinese come to catch the nestlings for market. In Peking a good singer brings five dollars, Mexican, and especially trained birds much more than that.

PAILING MIAO

With field-glasses we could see that Pailing Wang's palace was built in Chinese style, much like that of Sunit Wang, but by no means as large. In the low basin where we had camped, great quantities of purple iris and yellow pea blossoms gave a touch of color to the gray landscape. The trail to Pailing Miao led down a wide valley watered by an intermittent stream, the Aboukar Gol. In several side valleys we saw scattered elm trees, gnarled and twisted and very old, but never a sapling. It was further evidence that the existing climatic cycle is too dry for young trees to obtain a foothold. Our trail developed into a wide road some three miles from Pailing Miao, but led into a sandy stream-bed where the going was very heavy. Nevertheless, we got through with comparatively little pushing.

Where the river-bed debouched into a broad valley, we saw the mud walls of a considerable village, not far from the temple itself. Here were

Chinese traders, permanently established, who had considerable stocks of flour, tea, sugar, spirits, cloth, boots and other goods, which they sold and exchanged for wool, hides, cattle, ponies, camels and sheep. Most of the business is done by barter, and the Chinese almost invariably get the better of any transaction. They use false weights and measures, and even though the Mongol is not more honest, he is by no means as clever as the Chinese. Mongols hate to part with silver and often will give two dollars' worth of goods rather than pay a dollar in currency.

Pailing Miao, the "Temple of the Larks," is one of the largest monasteries of Inner Mongolia, and has, I believe, about fifteen hundred resident priests. Not only is it a junction for five or six of the great caravan roads, but it is in strictly Mongol territory and outside the immediate jurisdiction of the Chinese. Good grazing grounds for camels are in the immediate vicinity. Therefore, many caravans send their goods by cart to Kweihwating or Kalgan, to avoid the high cost of feeding camels in the cities. Kweihwating, in ancient times, was a Mongol trading center of much greater importance than any other place on the frontier. It is still called Kuku-hoto, the "Blue City," by the Mongols. It was the residence of a Living Buddha, and as such became a place of pilgrimage for Mongols and consequently a trading depot with Chinese merchants.

THE "WINDING ROAD" TO TURKESTAN

It was at Pailing Miao that Dr. Sven Hedin assembled his caravan in 1927, and started on his great journey westward to Turkestan along the same trail which we were to follow. From Pailing Miao, caravan roads lead to Urga, Uliassutai, Kobdo, Chinese Turkestan, and south to Paotowchen and Kweihwating. The trail which Hedin followed westward is one which has been reopened recently, and is known to caravan men as the "Winding Road." Its general line has been known for many centuries, but climatic changes, with increasing aridity, have converted the region through which it passes into a lifeless desert.

The usual trail to Chinese Turkestan was by what is known as the "Great Mongolian Road." A short distance from Pailing Miao this swings to the north of a line of low mountains and continues northwest along the southern base of the eastern Altai Mountains. It then turns southward to Turkestan. This was the trail which we intersected twice when, in 1925, we crossed the Altai at Ikhe Bogdo and at the Gurbun Saikhan, and it was in the main followed by Sir Francis Younghusband in 1887. It is the natural route to Turkestan because it taps the underground water and good grazing of the Altai Mountain slopes, and circles to the north of the great sand area.

In 1921, when Soviet Russia assumed control of Outer Mongolia, high

duties and intolerable oppression by the Buriat frontier guards made it expedient for Chinese caravans to open a new trail to Turkestan, which would keep south of the frontier in Inner Mongolia. Thus the Jao Lu, or "Winding Road," again came into use after having been virtually abandoned for centuries. In ancient times it was probable that this was a trail of communication between the now "dead" city of Khara Khoto, on the Edsin Gol, and Kweihwating. It leads through the most arid and inhospitable part of all Mongolia. Brigands cannot find support for even small bands along its course, and thus it is comparatively safe, although the desert exacts a heavy toll both in men and camels.

THE PROVINCIAL BOUNDARY BETWEEN CHAHAR AND SUIYUAN

We were told that our caravan was awaiting us fifteen or twenty miles to the west. Why they had stopped I could not imagine. The trail led us up and down a series of grassy hills, broken by many outcrops of hard rocks. Spock was happy, for the structure changed continually and he obtained most interesting data on the oldrock formations. Only thirteen miles from Pailing Miao we discovered our caravan camped near the trail. Tserin said that there was a yamen a few miles away, which had been giving all caravans so much trouble that he did not dare go on without our presence. The feed had been so poor all the way from Shara Murun southward that the camels were very hungry. Three had died, and I decided to send back thirty-one of the weakest animals, which we could relieve of their gasoline loads. The lamas at Baron Sog monastery would care for them, and they would be fat and strong upon our return.

I sent the caravan westward at three o'clock the next afternoon, with instructions to camp at the yamen. We rested for the day, as I was very weak and sick from the continual traveling. Many antelope, *Procapra gutturosa*, were reported near camp, and the doctor brought in enough meat to last us several days. The next noon we arrived at the yamen. It proved to be a tax station between Chahar and Suiyuan. The officials were decidedly nervous about asking us for taxes, but, as it was a legitimate provincial station and their credentials were quite in order, I was willing to pay ninety-one cents per camel, as did the regular caravans. The station consisted of several mud huts on the banks of a small, but clear, stream, called Hei Ne Ho. The Chinese had dug a well and planted a vegetable garden, watered by a cleverly contrived irrigation system.

NEWS FROM THE SVEN HEDIN EXPEDITION

That night, just before dark, we heard joyful shouts in Mongol and Chinese. Over the hill, out of the sunset glow, came a small caravan; the

men were running ahead, wildly embracing our Mongols. Soon we saw that it was a detachment of Sven Hedin's expedition, returning from Turkestan. There were twenty Mongols and three Chinese. Most of the former had been with us at some time and were old friends. Sitting in a circle there in the softly glowing twilight, with the aid of rude maps traced in the sand, we heard their story. Sven Hedin had had a good deal of political trouble at the Turkestan frontier, but finally had been allowed to proceed with some of his expedition. These men were returning with the collections to their homes north of Kalgan, after more than a year's absence.

They had suffered many a hardship on their return journey. All of them were gaunt, with hollow cheeks and hungry eyes. For weeks their only food had been camel meat and a few split peas. Money they had in plenty, but there were no Mongols who could sell them sheep; little water, no food and few inhabitants; sand-dunes of vast extent through which they had wandered for days seeking a passage for their dying camels; a country of utter desolation. It was not a cheerful picture. Nevertheless, I decided to push on as far as possible, for there might be fossil deposits which would be worth the effort. I hoped, too, that we could circle the sand to the north and still keep in Inner Mongolia.

A CHINESE MERCHANT CARAVAN

The topographers went ahead the next day, but I remained with the others to see the caravan safely past the yamen. Young, with some copper tube and several oil tins, arranged a most ingenious still. He spent all day distilling water for the batteries, while the rest of us wrote letters to be mailed from Kweihwating by Hedin's people. That night a caravan of Shansi men, with one hundred and fifty camels, camped at the yamen. They were carrying goat skins, on the return trip from Urumchi to Kweihwating, and had been ten weeks on the road. With them were two Chinese passengers; they rode in felt-lined boxes on either side of a camel. The boxes looked exactly like dog kennels. Although they were well-padded inside, one would think it must be torture to ride in them because of their small size. As soon as the camels arrived, the caravan men pitched a small tent for the two Chinese passengers, who enthroned themselves upon a pile of bedding and gazed out upon the world in a most superior fashion. Having spent the day in their kennels, one would have thought that they would like to stretch their legs a bit, but their only exercise consisted in walking from the camel to their tent.

The caravan men invited us to have tea with them. Fortunately, I can understand the Shansi dialect and was able to get a good deal of information regarding the country to the west. They told us that the great sand began

near a temple called Shandan Miao, and that it would be absolutely impossible to cross it with cars. Still, I was determined to push on and see for ourselves. These Gobi caravan men are hard-bitten fellows, with a certain reckless swing about their carriage and a terseness in conversation which suggests the wild, free plains on which they spend their lives. Owen Lattimore, in his book, "The Desert Road to Turkestan," 1929, has given a delightful account of their life and customs. It was on this same road that he spent four months with a caravan from Kweihwating outward bound to Turkestan.

OPIUM SMUGGLERS

We left the yamen at eight o'clock the next morning and immediately came to a long, sandy stream-bed where the going was very heavy. The rough, broken ridges of hard rocks, the beginning of the range known as Ungir Ola, necessitated such frequent turns in the trail that the topographers could make only very short "shots" and slow progress. We passed them at ten o'clock only twenty miles from the yamen. They had camped at dark the night before, near a well in the stream-bed, Yang Chang Tze Gol. Hardly had their tents been pitched before fifteen hard-looking Chinese armed with Mauser pistols rode in and camped near them. They were opium smugglers from Kansu, who had sold their drugs in Kweihwating and now were returning for another consignment. We had heard of their activities. They took a sheep whenever they needed it for food, but otherwise confined their robbing to fast ponies, except when some especially rich prize came their way. Granger arranged the four cars in a square with the tents inside and the spotlights illuminating all of the surroundings. The men remained on guard all night. Although the bandits doubtless would have greatly liked our rifles and cars, they were afraid to attack, as they saw that our party was well armed and watchful. After the smugglers made camp, one of them rode back along the trail to see if they were being followed. It was lucky that the topographers had four cars; if there had been but one or two they would certainly have had a fight.

These opium runners are usually much more courageous men than the ordinary Chinese bandits. On the outward trip, loaded with opium, they would not stop for ordinary robbery. They want only to be let alone. But on the return trip they become much more dangerous individuals. Motor cars would have been a heaven-sent method of rapid travel. At daylight next morning the bandits left. Our detachment passed them farther to the west. They were traveling at a fast trot, which would average about six miles an hour. Some Chinese living beside the trail told us about the smugglers, who were well known.

SHIRIGI-IN-SUMU, A DESERTED MONASTERY

In the afternoon we arrived at a deserted monastery, Shirigi-in-Sumu, which was the farthest point we had reached during our reconnaissance in 1925. Caravan men told us that there was a river eight miles beyond, at which we decided to camp. The river, named Haliu Ten Gol, proved to be a meandering stream which had cut a wide valley in the soft Cretaceous red-beds. Several caravans, with at least six hundred camels, were encamped there, and the place swarmed with tiny gnats. Even without the insects, we would not have remained in the vicinity of so many caravans. Returning to the ruined temple, we pitched the tents. We had seen a good many Dune Dweller artifacts, and Spock was anxious to investigate the geology of the region more carefully. He had discovered the cone of an extinct volcano just north of the trail, where the Ungir Mountains join the plain. The relation of several lava-flows to some small sedimentary deposits was a problem of importance. I determined to wait at the temple for our caravan, which should appear in a day or two.

In the short run of forty-two miles from the yamen, we had come into an entirely different region. The grasslands had gradually given place to an exceedingly arid desert, where the only vegetation was sparse camel sage, scattered over rolling sandy hills. The deserted temple stands in a great amphitheater among the hard-rock ridges, and is approached through a narrow gateway in the southernmost range. A good well has been dug in front of the temple. A few lamas still living there told us that a new monastery had been built three or four miles to the west. It is a desolate spot, for the black lava ridges and yellow sand are relieved by hardly a touch of green. We were told that there were wild sheep in the mountains, and I shot both species of antelope in the lowlands to the south. Chukar, or red-legged partridge, and quail were fairly plentiful on the ridges.

ACTIVITIES WHILE WAITING FOR THE CARAVAN

The next day, May 27, was quite the hottest of the spring thus far. There was a dead calm until about ten o'clock, when strong whirlwinds began to appear on the desert. McKenzie Young went back to the caravan to bring up a load of gasoline. He returned at four o'clock in the afternoon and reported that the camels were coming on very slowly, because they were weak from lack of food. We had already discovered that on this trail the caravan men carry dried peas for their camels. In no other part of Mongolia had I traveled a region which was so desolate that there was not sufficient vegetation to feed a camel. Along the trail we had passed several mud houses occupied by Chinese, and were told that these were "grain stations," and that the men raised or imported enough peas for the caravan trade. It was

obvious that if we were to go much farther westward we must buy peas for our animals. The caravans from Kweihwating bring about thirty loads of dried peas for every hundred loads of merchandise, according to Owen Lattimore, who traveled this same trail in 1926. Mr. Lattimore gives much interesting information about caravan travel, which is not easily obtainable from other sources.

Just to the west of camp, close to the base of the lava ridge, Granger and Spock investigated a small area of rock exposures which appeared as alternate layers of lava and sediments. Although they found no fossils, both men were convinced that the deposits were Tertiary. To the south we could see other exposures, but an afternoon's prospecting proved them to be almost barren. They yielded enough fragmentary dinosaur bones to indicate Cretaceous age. Four miles west of camp, Pond and Doctor Perez found a good many artifacts which belonged to the earliest Dune Dweller type. All along the trail similar artifacts had been present but not abundant, due, without doubt, to the scarcity of workable material.

In the evening, Shackelford set up the radio, and at seven-thirty picked up the broadcasting station at Vladivostok. Horvath, who speaks Russian, heard news of heavy fighting between Japanese and Chinese in the vicinity of Tsinan, Shantung. Time signals came in strongly from Cavite at ten o'clock.

Shackelford discovered a fox den the next day, in the side of a hill near camp. Doctor Perez and Buckshot dug along the course of the den, which ran upward and back into the hill for twenty-five feet. While they were resting, two young foxes ran out; one escaped but the other was killed by my police dog, Wolf, after an exciting chase. We were sorry, for we had hoped to keep them as pets. The topographers left in the morning, with Granger and Spock, to carry their line westward. The rest of us remained to await the caravan.

A SANDSTORM FOR A DAY AND A NIGHT

May 29 was an exceedingly hot day with a strong wind. The wind died at sunset, but about ten-thirty in the evening it began to blow hard. By eleven o'clock one of the worst gales I have ever experienced in Mongolia was howling down through the rocky gateway from the north. We lashed and weighted the tents, but it was impossible to keep out the blasts of sand and gravel. Doctor Perez and I weathered the first furious attack in the mess tent, but a great jagged window had opened in the back. During a sudden lull I looked out upon a scene of chaos. The cooks were homeless, their tent only a mass of ragged streamers. Three of the other tents were down; the rest sagged drunkenly.

Everyone had his own troubles, so many in fact that there was little we could do to help each other. Most of the men elected to remain where they were, under the flapping ruins of their tents, for those that remained standing were shelters in name only. The storm's first attack was the most vicious, but the others which followed in irregular salvos almost equaled it. Sleep was impossible. As for myself, I could hardly breathe. Seemingly a raging devil stood beside my head with buckets of sand, ready to dash them into my face the moment I came up for air out of the fur sleeping bag. There was something distinctly personal and living about the storm. All of us felt it. It was not just a violent disturbance of the unthinking elements. It acted like a calculating evil beast. After each raging attack it would draw off for a few moments' rest. The air, hanging motionless, allowed the suspended sand to sift gently down into our smarting eyes. Then with a sudden spring the storm-devil was on us again, clawing, striking, ripping, seeming to roar in fury that any of the tents still stood.

Thus it continued throughout the night. Now and then one of us would call to our companions in suffering, to be answered by smothered curses in three languages. The curses kept me cheerful. As long as a man can swear he is all right and in reasonably good spirits. After an indeterminate time, we knew that morning had come, by a change in the enveloping cloud from black to yellow. That the wind would drop with the sun we devoutly prayed. It did, and there were three hours of comparative quiet, allowing us to patch the least damaged tents. Then the particular devil that had been assigned to the day shift took up his duties with energy and vigor. We spent a miserable twelve hours huddled in fur coats, for it had become bitterly cold. One could neither read nor write because of the falling sand; conversation was possible only through half-closed lips. Nothing to do but sit and think. Personally, I just sat. The wind dropped a little late in the afternoon, and the caravan arrived. I took out supplies and directed Tserin to wait at the river until I sent him word. The camels were becoming so weak from lack of food that it was obvious they could not go on under such conditions.

STOPPED BY MONGOL SOLDIERS

Next day, much to our disappointment, we found that the topographers had made little progress. They had been stopped by Mongol soldiers about ten miles from the ruined temple. The Mongols had posted men with rifles on several hilltops, evidently expecting a fight from our people. Granger had explained our work to them, but they would not allow the topographers to go forward until they had reported to their prince, who was some fifty miles away. Since the Mongols had not returned, I told the topographers to break camp and carry on the work. The soldiers told Granger that so many caravans

had begun to use this trail that their prince was doing his utmost to keep it free from bandits. Granger said that his party had fared somewhat better in the sandstorm than we had, for they were under the lee of a hill, but that two of their tents had been badly ripped.

IN CAMP NEAR A DUNE DWELLER STATION

Doctor Perez was feeling badly and, by the time we met the topographers, had a temperature of 102 degrees Fahrenheit. I told Granger that we would run on and camp at the first well. It proved to be in a low basin among sand-dunes, but surrounded by a carpet of beautiful green grass. Pond discovered a Dune Dweller station near camp and spent the afternoon to good advantage. Doctor Perez was better the next morning, but still too weak to travel, so the topographers went ahead, leaving us to spend the day quietly. I, too, needed the rest, for the wound in my leg was not yet healed and was giving me a good deal of trouble. I had done a bit too much walking, and inflammation had developed about the knee joint.

THE LANG SHAN MOUNTAINS

The Lang Shan Mountains, a northward extension of the Kara Narin Ola range, were only half a mile to the south of our camp. Lattimore says: "The *lang* in the name Lang Shan is not from the word meaning wolf, but from an honorific title for young men of good birth. The mountains are associated with Chinese legends of the Pa Lang, eight brothers who are the heroes of a whole cycle of mythology, mostly concerned with the wars of defense and conquest between the Chinese and the border tribes. Erh Lang, the second brother, was the most celebrated of the eight and the mountains are named for him."[1]

DESOLATE AND ARID COUNTRY

The entire region was more arid and depressing than any other I have seen in Mongolia. It was totally unlike the Gobi as we had seen it north of the Altai Mountains. Each day the going became heavier, and we were literally fighting for every mile. There were none of the wide spaces of the northern Gobi. To be shut in, oppressed, by naked hard-rock ridges without the majesty of size; to plow through drifting yellow sand in valleys neither wide nor narrow; to look upon the bleaching bones of camels, dead from thirst or hunger! That is worth enduring only when it is producing valuable results. Thus far we had obtained almost nothing, and prospects for better success in the future were very dark.

[1] Lattimore, Owen. 1929. "The Desert Road to Turkestan." Little, Brown and Co., Boston. Pp. 92–93.

JUNCTION OF THE WINDING ROAD AND THE SMALL ROAD

On June 2 we reached a fine rolling gravel desert much like the smooth plains of the north. The advance party had turned off the trail sharply to the south, passing through a deep canyon, like a gateway in the mountains, occupied by a small stream. This is the spot where the Winding Road deviates from the Small Road which we had been following. Lattimore reports seeing mountain sheep at this place.

When we caught up with the topographers they were working in the center of a deep basin, fronted by a mountain ridge of hard rocks to the west. Granger said that they had left the main trail, or Small Mongolian Road, because some Mongols told them that it soon swung northward into Outer Mongolia.

IMPOSSIBLE CONDITIONS FOR PLANE-TABLE MAPPING

After tiffin we held a council. During thirteen days of travel the average distance had been only eighteen miles a day. This was due to the broken topography, necessitating very short shots, and to the extremely heavy, sandy going which was getting worse every mile. Obviously the method of mapping which we were employing could not be used successfully in this region, if we were to maintain the necessary speed. We decided, therefore, to abandon the plane-table map, with contours and levels carried by alidade, and continue the route map by prismatic compass with barometer readings for altitudes. We disliked to give up the more accurate type of survey which Major Roberts had initiated so successfully in the north, but the conditions there were utterly unlike those which we were now encountering.

THE LAOHU SHAN, OR TIGER MOUNTAINS

After tiffin our cars proceeded rapidly to the mountains which loomed before us in the west, known as the Laohu Shan, or "Tiger Mountains." Before long we entered a deep canyon, "Tiger Pass," which was filled with a chaotic mass of boulders and debris, over which no wheeled vehicle could pass. Lattimore reported sheep from these mountains, and said that a Chinese trader had many roebuck horns supposed to have come from the same place. Turning back, we cut across country northward to a small temple, Boom Ba-in-Sumu, which was visible in the foothills. The lamas were badly frightened and most of them fled to the mountains, but a few of the more courageous remained. From them we received needed information. They told us that the trail through the mountains was a short cut passable only for camels and ponies; that the main trail, or Small Road, which we had left, bent around the ridge to the northward before continuing into Outer Mongolia.

A DISAPPOINTING SEDIMENTARY BASIN

Proceeding across country, we regained the trail and camped at a great exposure of red sediments which margin a depression two hundred feet deep, known as the On Gong Gol. The spot gave every indication of splendid fossil-bearing deposits, and we thought that at last we had found what we had looked for so long. In a dry stream-bed in the center of the basin, Shackelford discovered a moist spot. He dug a well, lined it with a gasoline box, and in a short time we had an abundant supply of clear cold water. Doctor Spock remarked: "The desolate grandeur of the hollow, with its steep sided walls of scarlet clay, has caused it to be set aside by the Mongols as a holy place. In it no wells may be dug, no cattle are allowed to graze nor must any living thing be killed. According to the local belief this was a place where the youthful Buddha walked and meditated."

The next day, June 3, dawned bright and warm. Everyone prospected the badlands, but Buckshot was the only man who had success. His discovery proved to be a large sauropod dinosaur resembling *Diplodocus*. The bone was in very bad condition, and Granger soon saw that the best he could do was to take a few distinctive parts, which would serve as the basis for a description of the animal. Doubtless it is a new record for Asia, and pretty definitely places the formation as Lower Cretaceous. It was the only fossil of value which we had obtained since leaving Shara Murun. Strangely enough, the most diligent search of the acres of beautiful exposures did not yield another scrap of bone.

NEWS OF CHINESE POLITICAL AFFAIRS

That night, over the radio, we got the time signals perfectly from Cavite, and a few moments later Shackelford picked up our call letter from the American Legation in Peking. The message came in so distinctly that even in my tent, several feet away, I could hear the dots and dashes. Shackelford, Horvath and Hill took it down independently, then Granger and Shackelford squabbled like two crows over the translation, for the message was in code. Meanwhile the rest of us impatiently awaited the reading. At last we had the following:

> "Marshal Chang Tso-lin retreated yesterday to Manchuria. The Southerners are expected in Peking very soon. Everything normal in Peking and no trouble is expected. All are well. It is rumored that you are returning next week."

It was an interesting message for us. Since our permits were all from the Chang Tso-lin government, they would be worthless with the Southerners. It was fortunate that the change had taken place so early in the spring, for by

the time we were ready to return in the autumn an adjustment probably would have been made. Just how the "rumors" of our return could have arisen we were unable to understand. Still, I know of no other city in the world where there are so many rumors as in Peking!

All our Chinese were greatly excited by the news. The invasion of the Southerners was that of an alien people for them. To add to their depression, there was an eclipse of the moon that night. We watched the black shadow slowly swallow the bright orb until only the lower edge remained unobscured. The Chinese were sure that it augured badly for the future of their country!

GO YOTO BASIN, "THE VERY BAD PLACE"

The terrain was rapidly becoming impassable for our cars because of the drifting sand, and we had the statements of Hedin's party and the caravan men that motors could not possibly pass the great sand area farther west. We were exhausting our gasoline and men, wearing out the cars, losing many camels by starvation, and obtaining virtually no results. Unless there was a very decided change for the better, I determined to abandon the western exploration. However, I decided to make a reconnaissance to the west with two cars, leaving the others to await my report.

The next morning, June 4, Young, Hill, Spock, Perez and I left with two cars for the west. Sixteen miles took us off the smooth Cretaceous erosion plane and onto a hard-rock ridge, where the going was extremely rough. The black rocks were drifted with yellow sand and showed hardly a trace of green. Descending to a dry river-bed, the Go Yoto Gol, the "trail" turned directly down it, southward between high, barren, sand-swept rocky hills. It was inexpressibly desolate; like being enclosed in a sand-walled prison. Working slowly southward, pushing the cars every few hundred yards, we emerged at last through a narrow gateway into the great open Go Yoto basin. Behind us was the Laohu Shan and the exit from Tiger Pass. It was the edge of the vast depression which we had tried unsuccessfully to reach from the north in 1925, and where it appeared probable there would be fossil-bearing rocks.

In the distance a beautiful red mesa and many isolated red buttes showed encouragingly against the sky. We thought that at last our efforts had been rewarded and that we had reached the "Promised Land," but a closer view revealed that the escarpments were banked almost to the top with blown sand. Every one of the buttes in sight was in the same discouraging condition. The floor of the basin showed as a yellow blanket, but we pushed on, following a faint trail which branched off southward from the Winding Road and probably connects with the Kansu Road south of the Lang Shan. I use the word "push" advisedly, for that exactly expresses our progress. The cars could

go only a short distance under their own power; then, everyone out, and, with rope-bound canvas strips laid down in front, strain and push until the car had reached an area of harder sand. Such work is difficult at any time, but under a blazing sun it becomes doubly exhausting.

Two yurts were pitched well out in the basin and were occupied by Chinese, who appeared to be as desolate and miserable as the country in which they were living. They told us that the name of the region meant "The Very Bad Place." Three abandoned camels were lying beside the trail, alive but too weak to raise their heads. Gobi caravan men never kill an exhausted camel while on the march. They believe that its spirit might follow the caravan and cause trouble among the other camels. Instead, they leave it to die a lingering death of thirst or starvation. After these three were dead, the resident Chinese would strip them of their skins, which can be sold for five or six dollars.

THE END OF THE TRAIL FOR US

Eventually we reached a flat ridge near the end of the red mesa. It was only a quarter of a mile wide, and we looked down into another basin spotted with "tamarisk" bushes about two feet high, growing out of a heavy sand blanket. The trail led beside a long straight earth ridge, marked at regular intervals by rectangular mounds of rubble. We soon realized that this was the remains of an ancient wall. Possibly it is an outlying spur of the Great Wall of China. Gaining the top of the wall, we were able to make progress across the basin, where the cars could not possibly have negotiated the sand. Another flat ridge separated this basin from a third, filled with deeper sand and smaller "tamarisks." At last that was crossed. A fourth and worse basin shimmered with waves of heat. In its center the sand defeated us. Utterly exhausted from pushing, we left the cars where they were and dragged ourselves forward half a mile to the western rim. A depression so wide that its limits could not be seen lay before us like a yellow blanket, specked with olive green. It seemed to stretch to the edge of the world, a lifeless sea of burning sand. To enter it with motors was absurd; only camels could carry on to the other side. It marked the end of the trail for us.

There was nothing to do but return and camp beside the red mesa. While the cook was preparing dinner, Spock, Buckshot and Perez prospected the slope for fossils. A few spots which were free from sand gave no indication of bone, but the highly indurated state of the beds, together with the absence of any discernible deformation, led Doctor Spock to assign them tentatively to the Cretaceous. An extraordinary isolated pinnacle stands out at the western end, completely separated from the rest of the mesa. It is the one beautiful thing in this land of desolation. When we arose at daybreak the next morning, a strong wind swept in fierce gusts across the flats, filling our eyes and nostrils

with sand. It was a fair sample of what this God-forsaken place would be in a real storm.

ABANDONMENT OF THE WESTERN TRIP

The return trip to camp was fairly rapid because our outgoing tracks gave much assistance. When we reached camp I told the men that the western trip must be abandoned. Motor cars simply could not be used effectively in this region. Conditions were utterly different from those in Outer Mongolia where we had worked in previous years. There, the desert is of steppe formation and has a gravel floor, with sand only in infrequent dunes, long and narrow. Here, we were on the northern edge of the Ala Shan Desert, from which the drifting sand sweeps up to meet the true Gobi. Camels are the only possible transport for this region, and even they have great difficulty because there is so little feed. Sven Hedin's expedition, we learned subsequently, had lost more than one hundred camels out of the two hundred and fifty with which they left Pailing Miao, when they crossed this same region. Had we been obtaining important results in the different branches of science represented in the Expedition, it might have been worth while fighting the sand or leaving the cars and continuing on camels, but the returns for our investment of work and time were virtually nothing. Abandoning the western trip meant revising the entire plans of the Expedition. A great area of eastern Mongolia still remained almost unknown. There we would go, as soon as we could extricate ourselves from the devouring sand.

CHAPTER XXXV

SUCCESS AT LAST

SERIOUS CONDITION OF THE CAMELS

RETURNING, we found Tserin encamped at the river. Five of the camels were dead; many others could barely drag themselves along without loads. I told him that we would buy peas at some one of the stations along the trail. Otherwise, the camels could not make the return trip to Shara Murun. This trail to Chinese Turkestan must take a terrible toll of both animal and human life. As far as we had gone the way was marked with dead and dying camels. Nowhere north of the Altai Mountains had we encountered a region of such utter desolation, and all reports said it was much worse farther west.

HUNTING ARGALI

About fifteen miles beyond the ruined temple, Shirigi-in-Sumu, we camped near the base of the lava mountains, in order to give Doctor Perez and Horvath a chance to hunt sheep. Neither had ever seen a live argali and they were both wildly excited. I was sure that the species would prove to be *Ovis comosa*, the sheep that ranges through the mountains of the Sino-Mongolian frontier. Although there were no records of this sheep farther west than Paotowchen, at the end of the railroad, they certainly go as far west as the Laohu Shan, probably beyond that in all of the more or less connected mountainous district to the west and north.

We could find no ponies, or Mongols to guide the Doctor, but at daylight he and Horvath went out alone. It was a blistering hot day, and at noon Horvath returned, completely exhausted. They had found sheep in the first hour, missed a big ram, and Horvath had killed a small one. The Doctor continued alone. About five o'clock we saw a weird figure slowly approaching camp. It looked like a man, but had strange projections in the region of the ears. As it came nearer we made it out to be our surgeon. He was dragging painfully, just able to walk. A huge pair of horns rested on his head, while the neck-skin flapped disconsolately about his face. Soon he shifted it to his

shoulders. Then he tried either hip. When he saw that we had discovered him, he threw his burden on the ground, kicked it disgustedly, and collapsed upon a rock. Young drove out with a car to collect the remains.

The Doctor had had a hard day. He killed his sheep at about ten o'clock, many miles from camp. Then he discovered that he had forgotten to take a rope. A sixty-five-pound sheep's head is about the most awkward thing to carry that I know of, if one cannot make a sling to get it on his back. There was not a vine or a green branch on those bare hills, and the temperature in the sun was one hundred and thirty degrees Fahrenheit. Perez had his field-glasses, canteen, knife, rifle and ammunition, in addition to the head. By the time he had walked five miles and climbed up and down four ridges, he had come to hate the thing. He was sore all over and rubbed raw by the horn ridges. But it was a magnificent specimen and his first argali. The horns measured forty-one inches in length and nineteen inches in circumference at the base. Any sportsman can understand why he stuck by it. He said that he knew he never would return there, if he left it and went back to camp. The day was too hot, the way too long and the mountains too rough. He swore that his sheep-hunting had ended forever, but the next morning I noticed that he threw out tentative suggestions about another day's delay.

The Doctor had seen two other fine rams in his few hours' hunt, and we examined a dozen pairs of enormous horns along the base of the ridge. The Mongols assured us that the low mountains were full of sheep. Probably no other white men have ever hunted there, and the natives have no rifles. Leslie Simpson, the African sportsman, now holds the record for this species of sheep, beating one of mine by an inch or two in length. When I think of the great time and expense required for sportsmen to get to the western Altai Mountains, where most of the argali have been killed, I realize what a great opportunity lies within easy reach of Peking. This range of mountains is hardly more than one hundred and fifty miles northwest of Paotowchen; from the end of the railroad this means only a week's cart travel, or two days by motor. The only difficulties are bandits and war, but perhaps some day the Chinese will tire of asserting their "sovereign rights" and peace will again reign in their country.

PEAS FOR OUR CARAVAN

Twenty-three miles from the sheep camp, we found a mud hut, where the Chinese promised to have peas for our caravan in five days. After paying for them at the rate of nine cents per cattie (one and one third pounds), I instructed Tserin to come on to Shara Murun as fast as the camels could travel.

TAX HARRIERS

At the yamen there was a new lot of soldiers and officials. These were men of General Yen Hsi-shan, who had already replaced the Chang Tso-lin adherents. Although the former soldiers had collected taxes for one year in advance from the poor settlers, the new officials were busy levying their own particular taxes. The Chinese farmers thus are harried by every change of government in their particular region. How they manage to exist at all is a mystery. If they refuse to pay the taxes they are often killed or beaten into submission.

THE SHA KANG USU ESCARPMENT

The return trip to the Shara Murun district was accomplished without incident. We stopped north of Hospital Camp, on the edge of a great escarpment named Sha Kang Usu. The tents faced east, and a beautiful plain, swelling to rounded hills, lay to the south. Northward, behind us, was the saw-toothed rim of the bluff, from which we looked into a great basin splotched with streaks of bright red sediments. The exposures along the escarpment are mostly gray. The rounded hills of yellow gravel are the remains of the Oligocene, Baron Sog formation; the gray and red sediments represent the Eocene, Ulan Gochu formation, which I have already described at Hospital Camp. Just below the tents, water from the spring formed an intermittent stream in the basin, where sand-grouse continually came to drink. Two ruddy sheldrakes chattered and called, and twice we saw a fox disappear over the basin's rim; he must have had a wife and family in a burrow of the escarpment.

Captain Hill and Doctor Spock immediately began a topographic and geologic map of the badland area. Pond hunted artifacts, finding several stations close to the spring, and the palæontologists discovered skulls or jaws of titanotheres and hyænodonts before the first day had ended. The work went on most satisfactorily. Granger discovered half a dozen skulls and jaws of small carnivores, and several beautiful skulls and jaws of titanotheres were found by various members of the party.

A DUNE DWELLER STATION

One day Pond made a most important discovery. A picturesque Mongol rode into camp, carrying an antiquated flint-lock gun. Pond noticed that its striking flint was a beautiful Dune Dweller scraper. The old hunter said that he got it twenty miles away, where there were many of them. Next morning Pond collected the Mongol at his yurt. It required considerable patience to entice him into the car, and once there to prevent him from leaping out when the motor started. But his fright soon changed to exhilaration. He took Pond on a wild cross-country ride, for he evidently thought that a car could

go wherever a horse could travel. Pond said that the car did everything but fly.

Their destination proved to be a most unimpressive-looking spot, not far from the great lake basin southwest of the Baron Sog lamasery. It was merely a shallow depression among dead sand-dunes, but the artifacts were there in thousands and Pond returned to camp tremendously elated. For his work the Mongol received a silver dollar, three gas tins, a bottle, a package of cigarettes and a jam tin. He promised to guide Pond to two other localities, but his sudden wealth excited the jealousy of a wandering lama who happened to be in camp. The wretched priest told our Mongol that it was "bad joss" to show such places to foreigners, and forbade him to go again. It was obvious that Pond would have to camp at the station and spend a week or more of careful study. In the meantime, he found another great station south of Hospital Camp.

Granger had also discovered a great exposure of sediments, which obviously were identical in formation with those we were on, at a place called Urtyn Obo, to the north of us. I asked him to prospect them more carefully and, if he deemed it advisable, to move camp to the new locality. If he did so, Pond could go alone to the Dune Dweller site and finish his work.

RELAYING SUPPLIES BY AUTOMOBILE

It was necessary for Young and Horvath to return to the caravan with two cars, to bring gasoline and food to us. I estimated that, because of the weakened camels, the caravan could not arrive in less than three weeks. In the meantime, I wished to make a reconnaissance of the region east of the Kalgan-Urga trail. Without additional food and gasoline that would be impossible. Relaying supplies by car in this way was most expensive, but there was no other method, due to the breakdown of our camel transport.

Young and Horvath returned on June 14 after having made a record trip. The split peas had been delivered to the caravan and he had seen them safely past the yamen. With gas and food in hand, I decided to make the eastern reconnaissance at once.

RECONNAISSANCE EASTWARD FROM SHARA MURUN

On June 16 I started east with two cars, and Young, Hill, Spock and Perez, also three Chinese and a Mongol. We had gas and food for a week, and expected to run seven or eight hundred miles. On the first day before reaching Erhlien (Iren Dabasu), the pinion gears on one of the cars broke. This is an accident which never had happened before with us on a Dodge car, and was due to the terrific pounding which the gears had sustained in the sand on our western trip. Fortunately, we had another pinion with us and we camped

while Young changed it. The break had occurred in a sand-wash near a well, but in a difficult place to work. It was finished in time for us to reach Erhlien at four-thirty the next afternoon.

AT ERHLIEN

The telegraph operator was a genial old Chinese whom we knew from former trips. He said that no cars had passed on the Kalgan-Urga trail for a month, but that he expected four to arrive that evening. General Yen Hsi-shan was then in Peking and the political situation was quiet. We camped at our old historic site, where we had discovered the first Cretaceous strata in 1922. That evening the four cars arrived. One, a five-passenger Dodge touring car, was carrying sixteen hundred pounds of baggage and twelve passengers. The auto was almost obscured by human bodies, projecting at all angles. The chauffeur, a Chinese, reported many brigands near Chap Ser.

EASTWARD FROM ERHLIEN

After leaving ten cases of gasoline at Erhlien, the next morning we followed a trail eastward, along the edge of the salt lake and past the temple Boro-in-Sumu, and eventually turned to the south. We zigzagged back and forth for many hours trying to find an east and west trail. The caravan roads naturally all run in a general north and south direction, since Urga is their destination and there are no trading centers in the region we wished to explore. Since the Russians, who have done most of the topographical work in Mongolia, traveled on the main routes, few east and west trails are indicated on any map. Eventually we worked our way across a broad lowland studded with small unconnected lake basins, in the center of which stands a temple, Bulga-in-Sumu. Then we ascended to an enormous plain, and traveled on it for some distance without finding water. We had been on sediments most of the day, but there were no exposures good enough to warrant investigation. Captain Hill took compass directions at every turn, and our navigation was carried on exactly as if we were on a ship at sea.

THE GUR TUNG KHARA BASIN

Late in the afternoon we found a large trail which led us to a well in a deep depression, where we camped. We were then about fifty miles east and a little south of Erhlien, although we had traveled one hundred and twenty-five miles. The well, known as Gur Tung Khara Usu, lies in a deep basin surrounded by poorly exposed bluffs. At the nearest point we discovered fragmentary fossils and great masses of fresh-water clam-shells arranged in strata, associated with coarse, gray, cross-bedded sandstone. Evidently we were in an ancient lake basin, and the indications were that it might be Pliocene.

The late Tertiary formations were what we were hoping to find in the east, as they are notably absent in the western Gobi.

Next morning, while the cars were being packed, Doctor Perez and I had good sand-grouse shooting at a deep pit half filled with rain water, where the birds came to drink. Then we drove over to an exposure five miles from camp and just off the trail. It marked a part of the northern rim of the ancient lake basin. The exposures were bad, consisting mostly of coarse rubble, but on the very summit of the escarpment "Buckshot" discovered a mastodon skeleton partly exposed, also rhinoceros bones. This appeared to identify the formation as Pliocene, and we were correspondingly elated.

THE BAYING OBO PLAIN

Continuing eastward across country, we entered upon the largest and flattest erosion plain that I have seen in Mongolia. It was covered with sparse grass, but there was not a sign of water or evidence of any camp sites except old ones. Evidently the Mongols come there only in winter, when snow can be melted for water.

On a low hill was an obo, called Baying Obo, visible for a long distance. We discovered later that there is another obo to the south, both being used as landmarks for those Mongols who venture out upon this vast, waterless plain. They are "lighthouses" of the desert. Some miles beyond Baying Obo the plain gradually began to slope downward.

THE ULAN HSANDA BASIN

In a depression known as Ulan Hsanda, we discovered two yurts and a few sheep. A few patches of red sediments were almost devoid of fossils, but we did find one or two small fragments of bone and bits of turtle shell; also a good many recent bivalve shells of the type common at Chimney Butte. A Mongol told us that there was a well, Aligatu Usu, a mile away. There we found a Chinese trader with a hundred ponies, mostly mares. He had collected his herd two years previously, but because of the soldiers and brigands near Kalgan had not dared drive them to be sold. From the well a trail ran north by east through low granite hills. This is the boundary between the Gobi sediments of the Iren Tala and the surrounding mountain rim.

TSAGAN CHOLO HILLS

Three miles away was a fairly large temple, Tsali-in-Sumu, and another some distance farther on, Ershanti-in-Sumu. Our camp was made at sundown in the hollow of Tsagan Cholo, beside a well of good water among rolling hills of red sediments which, unfortunately, were unexposed. A little beyond our camp, parallel to the trail, one can just discern the ruins of an ancient wall

extending in a straight line out into the desert. When it was built, by whom and to what fortifications it belonged, are questions to which I can give no answer.

ON THE DOLON NOR TRAIL

After taking our position, Captain Hill reported that we were only a few miles south of the Outer Mongolian border. Of course we could not cross, so we searched diligently, the next morning, for a trail that would take us south and east. The topography consisted of thinly grassed hills of granites and schists. At last we crossed a trail going southeast and later discovered a Chinese caravan. They said that the trail divided soon, one branch going to Kalgan and the other to Dolon Nor. None of several north and south roads which we had passed was marked on the available maps, which gave no details of the country we were in. There were remarkably few Mongols, a circumstance which was surprising, as the grazing was not particularly bad and there was a reasonable number of wells.

The Dolon Nor trail was fairly good but led us through a succession of hard-rock hills. For tiffin we halted three miles beyond a point where there were three yurts, some very friendly Mongols, two wells, and a spring, known as Donda Hohu Hotogha.

A DISABLED CAR

When I started the car after the meal there was the sound of a suspicious grating in the region of the differential. In a few moments it became evident that the bevel, or ring, gear had broken. It was a bad accident, for we had no spare with us, although there were several in the main camp. Young immediately removed the rear end and found our fears realized. There was nothing to do but tow the car back to the wells, and leave it with two of the Chinese while we returned for the spare part. This accident, like the broken pinion, was due to the terrible strain of work in the sand on the western trip. In all our use of Dodge Brothers cars, in the previous years of exploration, nothing had ever happened to the driving-gears, and we had come to think of them as unbreakable.

RETURN TO ERHLIEN

The next morning we left at eight o'clock. We had given almost all our remaining food to the two Chinese, and money with which they could buy sheep from the Mongols. Seven men and gasoline made a heavy load for the single car, and we had many doubts about being able to negotiate the rough country between us and Erhlien. There was nothing else to do, however, and we started off full of hope, if not confidence. A friendly Mongol offered to

show us a short cut through the mountains. We had driven over granite ridges for nine miles when we suddenly came upon a large lamasery, Pailing-in-Sumu, which overlooks a small stream, the Biligh Gol. It was here, that, later, we discovered the first and only Pleistocene beds found during 1928. When the guide left us, Captain Hill laid a compass course for Erhlien, which we estimated to be about one hundred and twenty-five miles in a direct line. We saw only two or three Mongols, and they knew little about the country or trails except in their immediate vicinity. It was rather a trying experience to negotiate the great waterless plain. Had the overloaded car broken down we should have been in a serious situation. With little food and water and no Mongols, it would have meant a long foot march under trying conditions. However, the car plowed steadily onward, bumping over the rough terrain without a pause. Eventually we saw what we supposed was our "lighthouse" obo on the plain, but it did not check with Captain Hill's observations. It was much too far to the south. But Hill was certain that he could not be mistaken, and we decided, after a consultation, to continue on his course. Subsequently we discovered that there were two obos, almost exactly alike.

The headdress of the few Mongol women whom we had seen was quite unlike that of the women in the western Gobi or of the Chahars to the south. Two great oblong boxlike appendages of silver hung down in the region of their ears. The men were all friendly, but frightened and stupid.

At eight o'clock in the evening we reached Erhlien, pretty well exhausted from the rough ride and nervous uncertainty. It was evident that we had been traveling in the most extensive basin yet discovered in Mongolia, and that it was probably formed mostly of later sediments. It should yield excellent opportunities for future work, and doubtless give a new fauna.

NEWS FROM CHINA

At the telegraph station, welcome messages were awaiting us from Peking. One from the American Minister, Hon. J. V. A. MacMurray, read as follows:

> "Northerners withdrew toward Manchuria fortnight ago. Peking government discontinued. Peking-Tientsin area and northwest peacefully occupied by Shansi Nationalists. Advance of Shansi and Kuomintang toward Shanhaikuan still progressing. Good luck. MacMurray."

We heard from the telegraph operator that when the Northerners withdrew from Kalgan, and before the Nationalists troops had occupied the town, a thousand brigands had swept down upon it from the plateau. They had

looted certain sections of the city and demanded a ransom of five hundred thousand dollars from the Kalgan Chamber of Commerce. They remained in possession for two days, and left as the advance-guard of the Nationalist soldiers appeared.

COLLECTING AT URTYN OBO

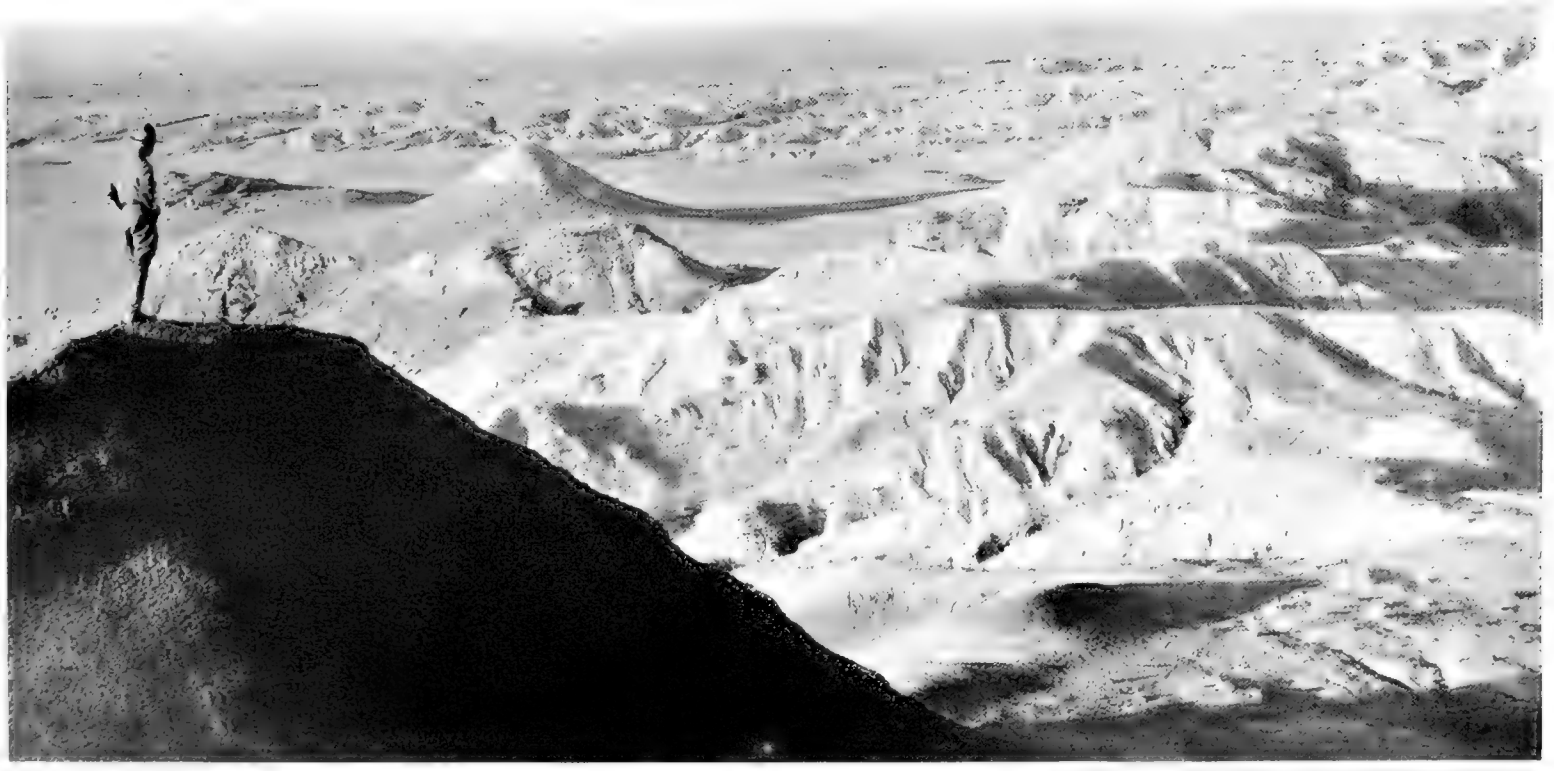
We felt sure that Granger would have shifted operations to Urtyn Obo, the great exposures which he had discovered, fourteen miles north of Spring Camp. Therefore we headed directly toward that spot. On the way I shot a gazelle at long range. It proved to be a female carrying young. While I was lamenting the fact, Doctor Perez jumped out of the car and quickly performed a neat Cæsarean operation. Lifting out the young antelope, which was just ready for birth, he employed artificial respiration and soon had it breathing naturally. It would doubtless have lived had it been uninjured, but my bullet had shattered both hind legs.

At four o'clock in the afternoon we saw the blue tents of our camp floating in a beautiful mirage. The camp was pitched on the rim of a great badland basin. We were very tired and very, very dirty. After tea, Granger led me to a great projecting buttress behind the tent. We looked out over a wild chaos of ravines and canyons and gigantic chasms, yellow, red and gray. An obo, built by the Mongols as an offering to the gods of this fantastic spot, crowned a sentinel butte. Sunset shadows filled the mysterious chasms with soft purple masses. Pinnacles and spires stood in silhouette against the sky. Over the tumultuous land sea lay the exquisite calm of a desert evening. Quietly my old friend told me of the first week's finds. His steady blue eyes filled with the light of affection and happiness as he saw me thrill with excitement.

"There," said he, pointing to the topmost layer of golden sands, the Baron Sog formation, "is where we find the bones of a new *Baluchitherium*. We do it with field-glasses. It is a new kind of fossil-hunting. I've never done it before, but it is the best way. We walk along the ridges and look across the ravines. See that white spot over there? That is a cervical vertebra I discovered to-day from this very spot. You will like this kind of prospecting."

"Below the yellow sands," Granger continued, "in that thick mass of red, the Ulan Gochu, there is nothing. So far we have found only a few bits of turtle shell in its whole extent. That gray-white stuff under the red is full of titanotheres. Probably it is also Ulan Gochu. Every one of the boys is working on a skull each one of which is good. The far layer of pink contains some fine things, and way out there in the bottom of the basin in those white sediments we seem to have a new fauna. Probably it is merely a facies of the

PLATE LXXXVIII.



PART OF BADLANDS AT URTYN OBO, 1928.

PLATE LXXXIX.

EXCAVATING THE *Baluchitherium* BONES DISCOVERED BY MR. SHACKELFORD, URTYN OBO, 1928.

upper gray, but anyway it is different. Thomson found an extraordinary rhinoceros there—a little fellow. I've never seen anything like it."

So the story went on; a story which set my heart to beating happily. After the long weeks of discouragement, the days and nights of pain and heat and utter exhaustion, at last the desert had paid its debt. I slept that night with a great load lifted from my spirit.

CHAPTER XXXVI

A NEW *BALUCHITHERIUM*

FOSSIL-HUNTING WITH FIELD-GLASSES

In the morning I tried the new method of field-glass prospecting. It was fascinating. Walking out on the narrow ridges between the ravines, I could look across, forty or fifty yards, to the other side. The powerful glasses magnified the surface of the yellow sands, bringing out in stereoscopic relief every pebble. Success was immediate. In the bottom of the first chasm I saw the white fragments of a huge bone. Following it up with my eyes, I found the source. A mass of bone lay just under the canyon's rim. Ten minutes' walk brought me to the spot. Most of the fossil remains were useless; simply a jumbled heap of great fragments without form or character, evidently from a limb bone broken by the action of weather. But in the slope, projecting only a few inches, was the great metatarsal of a *Baluchitherium*, nearly two feet long and as thick as my arm.

From this point I could see the opposite side of the ravine. Just above the barren red layer a spot of white appeared. That was something smaller and obviously different. It proved to be the broken jaw and teeth of an *Entelodon*, a giant pig that had teeth strangely like those of a carnivore. Building a little obo of stones, I left it severely alone. Had I tried to excavate it with my "pick and shovel" methods, Granger would have been furious. He loves to have me look for fossils, but how he does hate me when I try to take them out!

Two more ravines yielded nothing, but the third produced half a pelvis of our new *Baluchitherium*. And what a pelvis it was! Larger than a bass drum. I left that, too, for it was badly broken. An hour later a great cervical vertebra, beautifully preserved, showed on the side of the yellow cliff face, where it hung precariously balanced on a rotting ledge. A few more gales would have cut away its crumbling foundation and sent it crashing to the bottom of the canyon, two hundred feet below. With difficulty I hobbled over on my wounded leg and dragged the huge bone back to a place of safety. It probably

weighed fifty pounds. With the mass of muscle and tendons and the other six vertebræ, I could imagine what the neck alone, without the head, would weigh! Thus ended my morning's hunt. Other mornings followed, usually filled with as great success.

CONFLICT WITH LAMA SUPERSTITIONS

The night before, two drunken lamas had called at camp to inform us that there were to be great festivities about the obo, and that we must not work in the vicinity. I said little, for the priests were too much under the influence of Chinese wine to comprehend, but Granger and Thomson had a beautiful skull of a large titanothere, *Embolotherium*, partly excavated about a quarter of a mile from the obo. We had no intention of abandoning it, and at six o'clock that evening they brought it safely into camp. It was an enormous specimen, thirty-seven inches long; with great nasal bones which projected at a sharp angle into the air.

BALUCHITHERIUM BONES

On Sunday, June 24, Young and Horvath started for the broken car, guided by a map which Hill had prepared. The rest of us went into the badlands early. The slopes of the top Baron Sog formation are so abrupt that it was unlikely that we could find a skeleton of *Baluchitherium*. The animals must have been extraordinarily abundant during the Oligocene period, for broken fragments of the huge bones are scattered over the floors of most ravines. Hill, Perez and I discovered a fine cervical vertebra and the distal end of a humerus. I left Hill shortly before noon, and a few moments later he found the skull of a *Baluchitherium*, lying palate uppermost just above the rim of a perpendicular wall. It was in bad condition, and there was grave danger that it might slip off into the canyon, for the matrix was of rounded, yellow sand. Thomson did an exceedingly skillful job in bracing it up. The teeth and front of the skull were gone, but the top and occipital parts were of great value.

BONES AS BIG AS SHACKELFORD'S BODY

The next day Shackelford made an astonishing discovery. He came into the mess tent for tiffin and casually remarked that he had found a "bone." Rather too casually, I thought. I was sure that the half had not been told. After suitable encouragement he admitted that it was a large bone—a very large bone. Only the end of it was projecting from a hill slope, but that end was as big as his body. There was a roar from the table at that, for Shack's body is far from thin. He is not exactly globular, but he certainly is fat. "Don't believe me then," quoth Shack, "but I'll show you."

And show us he did. Walter Granger, Albert Thomson, Shackelford

and I went there in a car, for the place was two miles from camp. It proved to be a gray slope, which dropped off abruptly into a deep ravine. Ten feet down the side lay a great white ball. Until I examined it I would not believe that it was bone, for it actually was as thick as Shackelford's body. A little brushing off of yellow sand showed it to be the head of a humerus, or upper arm bone. More brushing exposed its entire length and brought to light the end of another massive shaft, which ran deep into the hillside.

All of us stared in amazement. It is not easy to ruffle the calm of Granger and Thomson. They have been at it too many years and have dug up too many strange beasts. But they got a real surprise when they saw those bones. As for me, I was too impressed even to talk. The size was almost terrifying. The humerus which Shackelford had found was as thick as a man's body and three and one half feet long. The second giant shaft proved to be the radius. It was nearly five feet long, and so heavy that two of us could hardly lift it. In order thoroughly to prospect the deposit, the side of the hill must be removed; it might reveal an entire skeleton.

So at seven o'clock the next morning half the men of the Expedition began shoveling energetically at the coarse yellow sand. The bones were so hard and big that there was little risk of breakage; therefore, Granger allowed me to work around them with a curved awl and a whisk-broom. My pickaxe methods do get quick results, but they are a bit rough on the specimens, I must admit. In the language of the Expedition, when a fossil is broken beyond repair it has been given the "R. C. A."

Before the massive radius lay bare for its entire length, Granger discovered another from the opposite side; also two enormous ribs. Just behind them, farther in the hillside, my brush exposed a corner of a flat bone; then a huge tooth, nearly as large as an apple, came into view. That gave all of us a thrill, for a skull with teeth meant that we could positively identify the specimen, but it proved to be only a jaw, and the left side was gone. The doctor next uncovered the middle metatarsal of one foot.

Then we paused to have a look at things. The shoveling squad had removed fifteen feet of hillside, leaving a flat bench where the bones lay exposed. They were all on the same level, close together, and the ends pointed in the same direction. It was obvious that the deposition had taken place in the bed of a swift stream, flowing north. The cross-bedding of the yellow gravel and the position of the bones told the story. The animal had died in the stream, the flesh decomposed and the skeleton disarticulated. The smaller parts had been carried on by the water; doubtless many had been broken by pounding against rocks. The massive limb bones had been left where the beast died. They were too heavy even for a torrent to move more than a few feet. It was useless to dig farther into the hill, for we were rapidly getting out of the

PLATE XC.

REMOVING THE BONES OF A *Baluchitherium* AT THE HOLY MESA, 1928.

A. CAPTAIN HILL SURVEYING AT URIAN OBO

B. GRANGER EXCAVATING THE SKULL OF AN *Embolotherium*.

stream-bed. Only excavations along the watercourse, northward, would yield results, but unfortunately a deep ravine had cut through it in that direction, and the ancient bed was gone. Extensive excavations farther into the hillside yielded no more bones, and we had to admit, reluctantly, that there was no hope of finding more at that spot.

OTHER FOSSILS AT URTYN OBO

Shackelford seemed to have especial luck in finding *Baluchitherium* remains. Part of another skull, without teeth, he discovered in a gently sloping draw. Like Hill's specimen, only the cranial part had been preserved. Shackelford was continually poking about in odd places, where no one else had prospected. During one of his rambles a few fragments of bone in the bottom of a shallow ravine caught his attention. Following up the line of the wash, he saw other pieces embedded in the earth. Excavations revealed a pelvis, with the hind limb in place, of what is doubtless a *Baluchitherium*. The bones were in the side of a small ridge formed by two diverging gullies. On the opposite slope parts of the animal's fore limbs were exposed. The great beast had died lying on its right side. As the bones are in their proper relative positions, it is highly probable that the entire skeleton is there. Unfortunately, the surrounding matrix is of tough, rubber-like clay. It can only be picked off bit by bit, and the bone itself is so soft that it must be continually hardened with shellac. It would require weeks of time and great quantities of material to remove this colossal skeleton. We had neither. There was nothing for it but to re-cover the bones with earth and obliterate all traces. We hoped to return in 1929 with proper materials and time enough to work out the bone.

In the meantime all of the men had made important discoveries in the way of fossils. The beds proved to be extraordinarily rich. New specimens could be found after only a few hours of prospecting. One of our Chinese collectors, alone, discovered five skulls of titanotheres, all worth taking. While *Embolotherium* outnumbered the rest, still there were other types, and also rhinoceroses. With the exception of Shabarakh Usu it was the most productive spot we had found in Mongolia.

CHAPTER XXXVII

NEW DISCOVERIES IN THE EAST

VARIOUS ACTIVITIES AT URTYN OBO

Captain Hill and Doctor Spock worked steadily on a topographic and geologic map of the badlands, an undertaking which necessitated an enormous amount of really hard labor, particularly as a spell of extremely hot weather had begun. Young and Horvath returned on June 27 with the disabled car, having made a very rapid trip. About the time of their arrival, Pond drove into camp from the south where he had been investigating the great Dune Dweller site shown him by the Mongol hunter. Thus all the Expedition was together again.

DUNE DWELLER ARTIFACTS

Before Granger moved camp to Urtyn Obo, he had gone for a day, with all the men, to help Pond do the rough collecting. They gathered five or six thousand specimens, and then left Pond, with a Mongol and a Chinese cook, to carry on alone.

The artifacts at this site represent the latest stages of Dune Dweller culture and are definitely Neolithic. Not only were thousands of cores and scrapers collected but "metates" and pestles, evidently used for crushing grain or seeds or possibly roots. Pond spent days sorting the material, and even then had several gasoline tins full of specimens. Later we made other important finds, which gave us a clearer idea of the Dune Dweller problem; therefore, I will reserve its discussion for a future chapter.

ANIMAL PETS

At Urtyn Obo, which we had named Baluch Camp, the Expedition began to resemble a traveling zoo, for it swarmed with young birds and animals. Shackelford rejoiced in the possession of two baby horned owls, which we had taken from a nest in a deep canyon east of camp. Horvath had a pair of ravens; Doctor Perez a beautiful falcon and a kite; Granger two golden eagles;

McKenzie Young a gazelle, and Buckshot a hedgehog. I was the fond possessor of a young duck caught by Doctor Perez. There were also a Mongol puppy and my police dog, Wolf.

All these birds and animals assumed a really important place in the Expedition. Being out of touch with the rest of the world for months, as we were, anything that would give a new interest and which would take our minds off our work and each other was valuable. The living animals assisted in keeping up the morale of the whole party. That is the reason why I was willing to sacrifice space and weight to our victrola. It was a mental relaxation and helped us to keep our sense of proportion. More than once, I have seen a man who was irritable put in good humor again by listening to a record of the "Two Black Crows" or watching the antics of one of our pets. Such things are wonderful stabilizers.

OBNOXIOUS LAMAS

During our entire stay at Baluch Camp we were greatly annoyed by the lamas. One dirty, bleary-eyed priest, who was conducting the annual celebration at the obo, was especially obnoxious. He wanted us to leave, but we were adamant, and then by various devices he endeavored to influence the lamas against us. His success was indifferent, for none of the others cared much what we did. Many of them visited our camp and were courteously received with tea and cigarettes. But the head lama and one of his satellites broke up several of our half-prepared specimens during the night. For the celebration many Mongols had moved to the great plain south of camp. A group of Chinese merchants also arrived, with a plentiful supply of very bad "kauliang" wine, which they sold to the lamas. As a result, the religious celebration was converted into a drunken orgy. For ten days the lamas remained at the obo, and very few of them were sober during all that time. We refrained from prospecting within half a mile of the obo, although that was one of the richest parts of the entire formation.

A SPELL OF TERRIFIC HEAT

On July 1, 1928, the temperature in the sun was 140 degrees Fahrenheit, and in the tents, with the sides lifted and a breeze blowing, it stood at 110° F. most of the day. As the work must continue, and there was no shade, the men simply had to endure the heat. The saving features were the extreme dryness of the air and the cool nights. By ten o'clock in the evening the temperature would drop to 70 degrees, no matter how fiercely the sun had blazed during the day. Thus we had a change of seventy degrees between night and day temperatures. This terrific heat continued for three weeks, without a break. None of us had experienced anything like it during previous years in the Gobi.

On July 4 we had our usual celebration, and I think none of the members of the Expedition will forget it for many years.

CARAVAN AFFAIRS

The camels had arrived at camp a few days earlier, in pretty bad condition. Half a dozen more had died, but those which we had sent to Baron Sog-in-Sumu from the yamen would enable us to carry on fairly well. After repacking our supplies, I sent all the weakest camels to Hatt-in-Sumu, with the fossils collected to date and the equipment which could be dispensed with. Tserin started with thirty-seven camels for the temple Bulga-in-Sumu, east of Iren Dabasu, to furnish a base of our new explorations.

NOM KHONG SHIREH, THE HOLY MESA

On July 7, four of us went north across the basin to investigate a mesa which we could see from camp with our field-glasses. I killed a female wolf, on the way, with a single bullet, at a distance of three hundred and fifty yards. In the stomach were the remains of three hares. Near the center of the basin, which is 620 feet deep, we discovered a well which had for its coping a pile of fossil logs. There were dozens of small, petrified trees with trunks and branches, partly exposed in Eocene sediments. Many of the sections were so excellently preserved that even the medullary rays could be distinguished.

The mesa proved to be thirty-six miles from camp, by the route we had taken across the basin. The sides were so abrupt that it was only after considerable investigation that we found a way for the cars to reach the top. The formation was exactly like that of Baluch Camp, but the upper layer of Baron Sog sands was rather thin in places. At the base we found a small obo built entirely of *Baluchitherium* bones. At the southeast corner of the mesa, on an outlying butte, stood a well-constructed obo, named Nom Khong Shireh.

There was a small trail leading across the mesa, which stands like a huge cake in the middle of a vast basin. Much to our surprise, there was not a sign of Mongols, or any old camp sites, even though the camel sage was more luxuriant than in any of the surrounding country. The trail led us to a well, in the basin off the northern end of the mesa. While we were prospecting for fossils, Doctor Perez almost stepped upon a wolf which was lying asleep in the shade of a rock. As the Doctor had left his rifle in the car, he contented himself with throwing a stone at the animal, which just missed its head. Fossil bones were plentiful and we determined to make this our first stop after leaving Baluch Camp. We found a fine trail, east of where we had crossed the basin, and returned to camp at seven o'clock. Because of the terrific heat the men had remained in the shade of the cars until the sun had lost a little of its strength.

SERIOUS LOSS OF GASOLINE

Our gasoline supply had been severely depleted by the extraordinary heat, although it had been packed with unusual care. The tins had been reinforced by extra soldering, the cases made of heavier wood, and considerable space left for soft packing and expansion. Nevertheless, the change of seventy degrees between night and day temperatures induced such extraordinary expansion and contraction that many of the tins burst along the seams. During the night there were continual explosions, like fire-crackers, which meant other empty tins in the morning. We had taken out four thousand gallons, but the heavy work in sand, on the western trip, had required an unusual amount. The new difficulty of heat made me realize that, unless we husbanded our remaining supply with the greatest care, we should not have enough for the eastern explorations.

OPERATIONS AT THE HOLY MESA

Although we had by no means exhausted the fossil riches of Baluch Camp, I decided to move. The map had been completed, Pond could find no new archæological sites of interest, and the palæontologists were the only ones who were busy. Since the Expedition had been arranged for reconnaissance, I felt that we must utilize our men, and return next year with a different staff to complete the fossil work. That was the method we had used throughout the Expedition, and was the only way to prevent loss of time and energy.

On July 9 we were off at daylight, and were in camp at the mesa at 9: 15 in the morning. Nom Khong Shireh, the Mongols call it. Although the heat was almost unbearable, we prospected in the morning, and Buckshot found two huge cervical vertebræ larger by far than any other bones of *Baluchitherium* that we had ever seen. Granger discovered the distal end of an enormous radius, and a small rhinoceros jaw was my contribution.

The heat continued the next day, but all the men went early into the badlands. The results were a fine *Entelodon* jaw and several rhinoceros skulls; also two femurs, one radius, a tibia and fibula and one dorsal vertebra of a small *Baluchitherium*. Since the bone was as hard as flint, the excavations could be carried on rapidly. That night was the hottest night of the summer.

The temperature at ten o'clock was 85° F. in the tent. I was sure that such unusual night heat presaged wind the next day and we were not surprised to find a gale raging when we awoke. During the next twenty-four hours, the wind boxed the compass twice. Although the men tried to work in the fossil fields, they gave it up before noon.

Several very dirty lamas visited us, and announced that the mesa was a very holy spot; so holy, in fact, that no Mongol was ever allowed to camp there. Would we please leave immediately? That accounted for the absence of

Mongols on the mesa, and the abundance of camel feed. We had crossed the provincial line, into West Sunit Wang's territory, somewhere between Baluch Camp and this spot. I told the Mongols that we had almost finished our work and would leave in a day or two. That was quite true, because the mesa was so small that we had pretty thoroughly explored it. In most places the sides were precipitous, and at the southern face a remarkable wall of red sediments, with a knife-like crest, projected far out into the basin.

Due to the absence of Mongols, the mesa swarmed with birds. Every few yards we would disturb huge horned owls, sleeping in the semi-darkness of a crevice; also others of a smaller species. Our indefatigable hunter, Doctor Perez, found several wolves, and the abundance of gazelle remains showed that they had taken a heavy toll of these animals. Falcons and eagles were almost as abundant as owls.

Granger discovered an enormous pair of jaws, with teeth, in the top Baron Sog layer, but they were not *Baluchitherium*. Pond found several graves and, as he had nothing better to do, decided to open one. Obviously they were pre-Mongol and belonged to the same people who made those at Ula Usu, which Nelson investigated. Pond found part of a human skeleton and bones of three sheep, but no implements. The grave was exceedingly well made, the lower part having been cut out of solid rock.

Nine lamas visited our camp and insisted so strongly that we leave at once, that I decided to go on the morrow. Although further prospecting would doubtless reveal more specimens, we already had the cream, and next year we could give it a more thorough search. It would not be worth while to rouse the lama population against us. We named the camp The Holy Mesa.

NEWS FROM CHINA AT IREN DABASU

July 14 dawned with a little rain and heavy clouds. It was a fine day to travel and a great relief from the debilitating heat of the last fortnight. Leaving at eight o'clock, we stopped for a short time to examine with field-glasses another great escarpment east of the Holy Mesa. It is of the same formation and would be well worth investigating. The drive to Iren Dabasu was quick and uneventful, and we camped again at our old spot by the Cretaceous ridge.

From the telegraph operator we learned that Nanking had been made the capital of China, that Peking was changed to Peiping, and that the control of the country had been divided between Chiang Kai-shih, Feng Yu-hsiang and Yen Hsi-shan.

THREE SETS OF DINOSAUR EGGS

The next day Granger and the others drove over to the place where we had discovered dinosaur eggshells in 1923. Digging into the slope, they found

PLATE XCII.

THE OBO AT THE HOLY MESA, 1928.

PLATE XCIII.

ANDREWS COLLECTING YOUNG KITES AT URTYN OBO, 1928.

three sets of eggs, close together but all badly broken. They are about six inches in length and not as elongate as those of Shabarakh Usu. They look very much like large crocodile eggs, but Doctor Van Straelen, who examined some of the shells microscopically, stated that they were definitely dinosaurian.

IREN DABASU TO GUR TUNG KHARA USU

On July 16 we left at one o'clock, stopping to collect some dinosaur eggs which Granger had pasted and left to dry. Near-by was a large Dune Dweller station, and Pond collected a large amount of material. Tserin had not arrived at the Burned Temple, Bulga-in-Sumu, east of Iren Dabasu, which was our rendezvous, so we drove on to the escarpment where we had discovered the mastodons on our eastern reconnaissance. The tents were pitched on the very rim, overlooking a basin so vast that it was like gazing down upon a calm, yellow-green sea. Three and a half miles south of us was the well known as Gur Tung Khara Usu, from which we obtained water.

PLIOCENE LAKE BEDS OF THE TUNG GUR FORMATION

The next day Buckshot and Thomson began work on the mastodon skeleton which the former had discovered on our initial visit. It proved to be that of a very young individual, but most of the skull was there. The long spatulate jaws were most astonishing. To the northeast, Hill and Perez found a series of beautifully exposed badlands, and much bone. Only a quarter of a mile from camp, in some gray sediments half-way down the slope, Chang, one of the Chinese collectors, discovered a very fine rhinoceros skeleton. The skull and virtually all of the bones were in place. After it had been exposed it made a splendid exhibit. The animal had died in a very gently flowing stream, and the posterior part of the skeleton had drifted slightly away from the anterior part.

The formation is Pliocene, and new. It was named the Tung Gur formation. The Pliocene is very limited in the western and northern part of the Gobi, which we had explored in previous years, only the small Hung Kureh beds, at the base of Baga Bogdo, having been identified. Père Teilhard de Chardin had described Pliocene in the region of Dalai Nor, in Inner Mongolia, and Andersson found it at Ertemte, near Hatt-in-Sumu. Tung Gur, however, was the first extensive deposit to be identified in central Mongolia. We felt quite sure that the red sediments near P'ang Kiang were a lateral, southwestward continuation of the Tung Gur and associated Pliocene formations, but this correlation was made on structural grounds only, as no diagnostic fossils were found. From the overlapping of lake and stream deposits, Doctor Spock concludes that the Pliocene was a time of climatic fluctuations.

It soon became evident that at Gur Tung Khara Usu we were working on the shores of a great Pliocene lake, the edges of which are thickly inlaid with pelecypod shells. It is only in the shell layer that the fossils occur. Many of the bones are in a yellow sand, which evidently was the shallow water and beach sediment. Lower down, there is a hard, marly limestone layer, marking the deeper water. We happened to camp on the shell layer itself, where the fossils are weathering out of the surface. The Pliocene fauna was all new to us. In addition to the mastodons and rhinoceroses, Granger found bones of a huge chalicothere resembling *Moropus*, and of deer, gazelle and turtles.

From the badlands to the northeast, Captain Hill brought in a most extraordinary flat plate. It is about ten inches long, nine inches in width, and three quarters of an inch thick. It is covered with enamel and is obviously a tooth. But what sort of beast could have used a tooth of that sort, we were unable to imagine. Granger, Thomson and I puzzled our brains about it for days. Three others were found. They gave no further clue to the situation, and we came to believe that a most remarkable animal must have frequented the shores of the lake in Pliocene days.

The badlands to the south also offered interesting possibilities, and six of us spent the day there. Although there was much bone, it was mostly fragmentary. We discovered one good rhinoceros jaw, and the scapula belonging to a huge mastodon.

RECURRING RAINSTORMS

Every afternoon, at about five o'clock, a strong west or northwest wind began to blow. We could see the storm advance across the basin, driving before it a blanket of sand, and backed by an ominous black rain-cloud; not once since our arrival had we escaped the visitation. I sent Young and Thomson over to the temple one morning, with a load of fossils to deliver to the caravan. Just before they started back the heavens opened, emitting such a deluge of rain as I have rarely seen in Mongolia. A yellow flood poured down the slopes of the escarpment, and in a few hours the basin floor had become a lake. The men could not return until the next day, and reached camp only with the greatest difficulty. The well, two miles from camp, where we obtained our drinking water, was flooded. After considerable searching, another well, eight miles distant, was discovered.

Granger was caught in the northern badlands during one of the daily rainstorms. He crawled into a shallow cave for shelter, and found it occupied by a hare. The animal looked at him for a few moments and then decided to leave. It hopped out into the rain and disappeared. A short time later the hare returned, very wet and bedraggled, and sat down beside him under the ledge. They both remained until the rain ended!

A TRIP TO HATT-IN-SUMU AND RETURN

Some of the fossil bones were so large that they could not be carried on camels without grave risk of breakage. Therefore, I decided to take two carloads to Hatt-in-Sumu, and try to buy more gasoline at P'ang Kiang. Young, Hill, Spock and I left on July 22. After filling our cars at the caravan, I instructed Tserin to proceed immediately to camp and we struck southward on a good trail which eventually led us to the main Kalgan-Urga road near Irdin Manha.

General Yen Hsi-shan's soldiers had so successfully cleared the plateau of brigands that trade had begun in great volume. We saw about two thousand carts on the road; more than at any time since 1918. The men said that the bandits had all gone to the west and that the road was entirely safe. At P'ang Kiang, where we spent the night, the telegraph operator told us that Marshal Chang Tso-lin had been killed. His train had been bombed, just outside of Mukden, during his retreat. It was supposed to be the work of Japanese, but nothing definite had been established. His death had been kept a profound secret for three weeks. At P'ang Kiang we were able to buy eight cases of gasoline; it was the first time in three years that gasoline had been on sale because of the bandit troubles.

On the road we met Wang Hung-bing, a chauffeur who had been with us on the 1922 and 1923 expeditions. He had taken down letters which we left at Erhlien to go by the first car. On the way bandits held him up and took everything he or his passengers had, except our letters. They realized that those were useless to them.

There had been a terrible rainstorm over all the grasslands of southern Mongolia and just after leaving P'ang Kiang we came into veritable seas of mud; it was only with the greatest difficulty that we negotiated the fifty miles to Hatt-in-Sumu. There we found Mr. Eriksson and Larsen. The latter had just returned from the Hedin expedition, via Russia. He said that it was a very good thing we had not pushed farther westward toward Chinese Turkestan, for the sand was quite impassable for any wheeled vehicle. Eriksson reported that in the storms of the day before ten Mongols had been drowned and many yurts swept away, in a valley about ten miles from Hatt-in-Sumu. A flood had rushed down from the hills, carrying so much dust in front of it that the Mongols thought it was merely a sandstorm, and were caught unaware.

We left the morning after reaching Hatt-in-Sumu, and made a quick run to P'ang Kiang because the road had dried amazingly under a hot sun and a strong wind. We purchased three more cases of gasoline at sixteen dollars, Mexican, a case. Nine miles north of the station we turned off northward, on a trail which we hoped would bring us out near camp. Even with

our light cars, it was difficult traveling through the heavy sand. Twenty miles from camp we saw the fine exposures which we had first discovered on our eastern reconnaissance, and I determined to make them our next stop. It began to rain early in the afternoon and before we reached camp it was difficult to see to drive. Captain Hill, as navigator, had done a splendid piece of work, and brought us home without the slightest hesitation.

PROBLEM OF GASOLINE SUPPLY

The caravan had arrived, but the gasoline situation was serious. Out of twenty-four cases, Horvath had obtained only twelve. I decided to condense all the remaining gasoline into full tins and carry it with us in the cars. In that way we could eliminate leakage, and know exactly how far we could go. The rain continued steadily all night and next day, but Young and Horvath had a busy time opening and resoldering the gasoline tins.

CHAPTER XXXVIII

THE SHOVEL-TUSKED MASTODON

CAMP AT TAIRUM NOR

We broke camp on July 26 and drove twenty-two miles across a level upland to a place where a precipitous escarpment fronts the long narrow depression of Tairum Nor. A good well, named Min Gan Usu, near the top of the scarp, was surrounded by Mongols, but most of them scattered like birds as soon as they saw our cars. Two or three of the more courageous awaited our coming with obvious fear, but were soon reassured by gifts of cigarettes. Our new camp was on the edge of the steep bluff, looking out over the shadow-flecked lake basin of Tairum Nor, where, in the lowest part, a thin film of water spread over red mud.

FOSSILIFEROUS EXPOSURES AT TAIRUM NOR

On the far side of the lake were gray and white exposures, which proved to be Cretaceous, but not richly fossiliferous. The exposures near camp had a top stratum of yellow sand and gravels on which we were camped; below this a thick layer of red sediments; then gray sediments, and at the very bottom another red area. Although the formation is the same as the Pliocene Tung Gur, the sequence of beds is quite different. The first afternoon two more of the broad, flat, tooth-like plates were discovered in the top layer, and the middle gray bed produced a fine rhinoceros skull and jaws.

AN ANCIENT GRAVE

There were many ancient graves at the foot of the escarpment, and Pond decided to open one of the largest. It was a strenuous job because of the heavy rocks, but, with the assistance of Shackelford, Hill and several of the Mongols, they at last reached the bottom of the grave. There was a beautifully preserved skeleton, lying on its face. The body evidently had been clothed in a robe or dress of fiber, to which beads made from bits of fresh-water clam-shells had been attached. Doubtless these were the same shells

that are so abundant in the Pliocene formation of the region. The fiber had disappeared, leaving only the circular beads of shell. There were no artifacts of any kind in the grave. Pond carefully removed the skeleton and then closed the grave.

THE SHOVEL-TUSKED MASTODON, *PLATYBELODON*

The new camp was somewhat disappointing in the fossils produced; the exposures were so extensive that perhaps we had expected too much. Five days sufficed to prospect the beds, and we decided to move to the east. I gave orders to break camp at daylight the next morning. Granger said: "There is a corner I haven't looked over yet. This afternoon I'll see what is there."

He took two of the Chinese collectors with him, but they found nothing of importance. It was almost dark and Granger was on his way back to camp. He climbed the escarpment to the plain on which the tents were pitched. Two feet below the edge he stepped on a fragment of bone. There were more fragments scattered about, and a large piece firmly embedded in the earth. After a little excavation he realized that he had solved the mystery of the flat teeth, and returned to camp to get me. What he had discovered proved to be the lower jaw of a mastodon, similar to the one found at "Elephant Camp," but much larger. The spatulate front of the jaw can be described only as resembling a great coal shovel. Side by side, horizontally, in the distal end were two flat teeth like the others we had found. They were eighteen inches across. Behind them, the jaw narrowed and then divided into the two branches which bear the molar teeth. The jaw was more than five feet long—a perfectly stupendous organ.

It resembled a scoop shovel, and a scoop shovel it must have been. The fact that we found many mastodon remains on the very shores of the great Pliocene inland lake gives a clue. Quite probably there was much lush vegetation there. I can imagine our mastodon wading along the edges, scooping up the succulent water plants with his great shovel. By means of a trunk or elongate upper lip, he pushed them into the back part of his mouth, to be masticated by his molar teeth.

We thought that we had discovered something entirely new, for we did not know at that time of the remarkable skull found in Nebraska by Professor Barbour, which he named *Amebelodon*. Examination in New York proved that our animal represented a larger species of a related genus, *Platybelodon*. In the meantime, Doctor Borissiak had found another *Platybelodon*, in Russian Turkestan. Certainly this animal will stand for all time as one of the most extraordinary adaptations to environment in the animal kingdom. We discovered half a dozen lower incisor plates, all on the shores of the ancient lake,

and I feel quite certain that our theory as to the aquatic feeding habits of *Platybelodon* is correct.

DUNE DWELLER ARTIFACTS BETWEEN TAIRUM NOR AND THE DOLON NOR TRAIL

After Granger and Thomson had brought in the great jaw, the morning after its discovery, we broke camp and drove eastward toward the trail on which the car had been disabled during our reconnaissance. Tserin, with the camels, was twenty miles away, and we delivered to him five boxes of fossils, the results of our work at the Tairum Nor camp. Within a few yards of his tent, Pond found a Dune Dweller station. With all of us searching, a good many artifacts were brought in during the stop for luncheon.

In a sandspit, near a temple called Bailing Miao, the bevel gear of the touring car broke, another result of our hard work in the sand to the west. Horvath and Young set to work at once, but it was not repaired until the following noon. Strangely enough, again we had stopped almost on a Dune Dweller station. All about the tents were artifacts, some of them especially fine. The next morning a lama volunteered to guide Pond to another station a few miles away. They got six bags of artifacts and were back for an early tiffin at eleven o'clock. At almost any spot where we stopped it was possible to find artifacts. Without doubt, the abundant water supply, in the way of ponds and streams, made this region fairly fertile during the last moist cycle, and there must have been a dense population of Dune Dwellers. Even to-day it has much more water than the country to the west.

TRAVELING IN RAIN AND COLD WEATHER

After tiffin we proceeded to the Dolon Nor trail, where the car had broken down on our first reconnaissance. Suddenly an enormous cloud appeared in the north and west, approaching rapidly. Realizing that the storm would soon hit us, I told the men to get what shelter they could under the cars. For twenty minutes the rain descended in a veritable flood. The trail led through a great basin, but after two attempts we realized that the cars could not make their way through the water that had accumulated in the lowland. It seemed possible to circle the basin on the hills to the east. The going was heavy, for everything was soft and slippery. It had become bitterly cold and all of us were shivering, even in fur coats.

A magnificent herd of gazelles, *Procapra gutturosa*, suddenly appeared in front of us. There must have been at least twenty-five thousand bucks, does and fawns, running on all sides of the cars. We continued across the rolling plains for a long time, without finding a sign of Mongols or a well. The trail must have turned off at a sharp angle, for we could not pick it up. The men were wet and shivering with cold; moreover, darkness was fast

approaching. About seven o'clock, when the cars had been running in low and second speed for many miles, we saw two yurts in the distance, and knew that a well could not be far away.

HAILSTONES AN INCH IN DIAMETER

Suddenly a great area of white appeared in front of us, and presently we came to a plain covered with enormous hailstones. Some of them were more than one inch in diameter—the largest that I have ever seen. We camped not far from the yurts. A hot dinner put new life and warmth into our bodies, and we sat about the table until late, exchanging stories of our experiences during the trying day. This was on July 30, yet the temperature dropped to the freezing point that night.

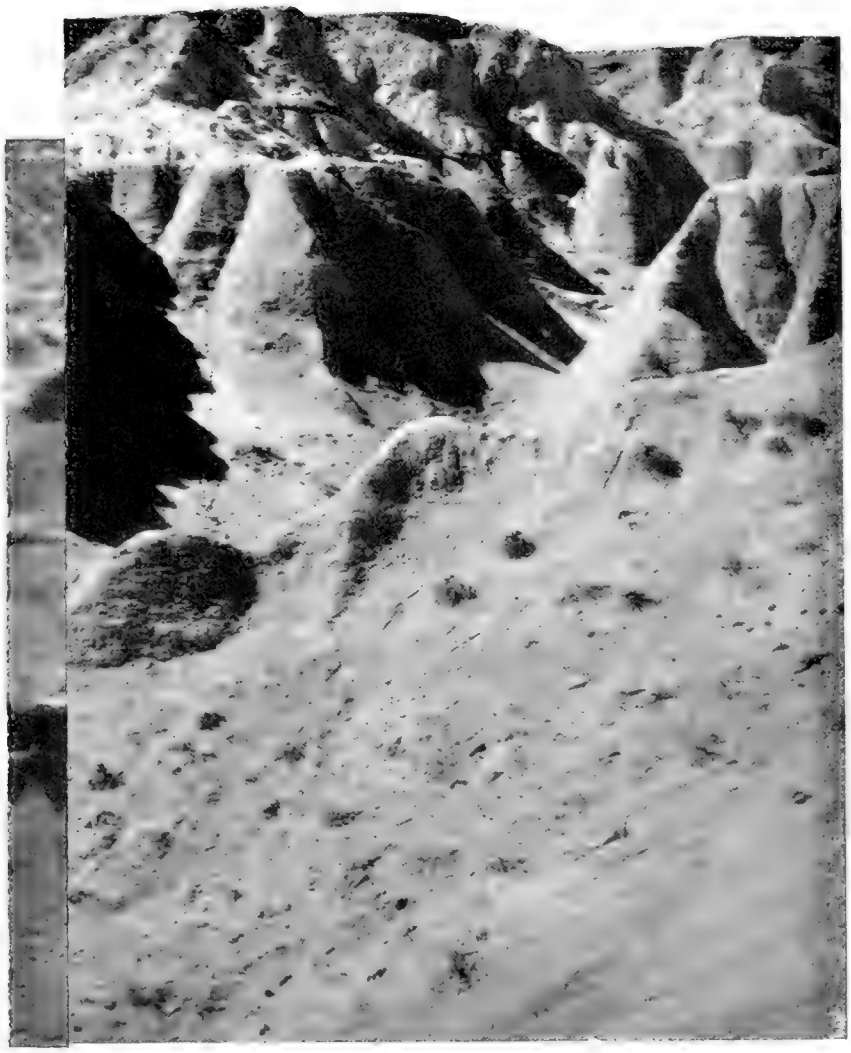
The next morning was dark and cold, with spurts of rain, so we postponed moving until the weather had definitely cleared. Thomson and Granger found half a dozen sand-grouse, which had been killed by the hailstones; Doctor Perez brought in a kangaroo rat, a cony and a hamster, all dead from the same cause. Numbers of hawks, eagles and falcons were circling above the plain, evidently attracted by the slaughter of small game. The storm must have taken a considerable toll of life. The Chinese found three sand-grouse that had been only stunned and slightly injured by the hail, and these we kept alive until the next day. Eighteen hours after the storm, Shackelford gathered a pail full of hailstones, many of which measured one and one tenth inches in diameter. They must have been very much larger at the time of falling.

THE BARRO UNDUH UPLAND

The Mongols at the yurts gave us interesting information. They said that we were close to a trail which led to a small lake called Koko Nor; that, from there, a trail led to a very large lake, known as Hul Tsagan Nor. We decided to try to reach the latter, as it must lie in a considerable basin where there would almost certainly be exposed sediments. The upland where we were camped was known as Barro Unduh. Many of the undrained hollows are occupied by small semi-permanent lakes. At present, the largest of these is about seven acres in extent, but in recent geologic times they were much larger, as shown by beach deposits at higher levels than those of to-day.

KOKO NOR

August 1 was a beautiful, sunny day, cool in the morning but extremely hot in the afternoon. Traveling south on the trail, we reached the small lake, Koko Nor, near which was a very poor and dirty temple, Koko Nor-in-Sumu. A dozen Chinese Mohammedans from Kansu were there, and at least half



bright

of them were ill. Doctor Perez gave some of them medicine, but three were in advanced stages of syphilis. We were told to go southeast on the road from the temple, and cut across country to another trail, which would lead us to the large lake, Hul Tsagan Nor. The terrain was very heavy after the rain and it was necessary to make many detours to avoid mud in the lowlands.

VILLAGE OF EAST SUNIT WANG, AT UNDUH CHOLO

Leaving the trail about half a mile south of the temple, we ran across rolling grassy hills to a flat meadow, where there were seventeen yurts. Closer inspection revealed that all of them were large, and one extraordinarily so. It had an ornamented red door, in front of which were three tall posts with gilt tops. The yurts were arranged in parallel rows and the surroundings were unusually clean. We stopped the cars and were greeted by some rather surly Mongols, who informed us that this was the village of East Sunit Wang, and that the place was known as Unduh Cholo. The Prince himself was at a temple to the west, where a great celebration was being held. We took some photographs, and the Mongols were obviously very frightened. They vouchsafed the information that a small trail to the east, along a natural causeway between two lakes, would lead us to the great lake, which was not far away. Halting for a few moments a mile from the yurts we found a Dune Dweller station where artifacts were scattered about in hundreds. It seemed to make no difference where we stopped; artifacts were always present, showing what great numbers of these primitive people there must have been during Dune Dweller days.

ATTEMPT TO REACH HUL TSAGAN NOR

The trail was very bad and led us across a large basin, where mud and water made the traveling exceedingly difficult. The bordering escarpments were of fine gray clays, lake sediments, which, although beautifully carved by weathering, were barren of fossils. On a high hill stands Tchanting Obo. From the summit we could see the large Hul Tsagan Nor only a few miles to the north, but blocked from us by impassable sand. The trail led through low hills and appeared to swing around to an arm of water. Attempts to reach it ended in failure, due to heavy sand. We were all exhausted by hard pushing, and I decided to camp at a pond near which is the small temple, Ungur-in-Sumu. The water was muddy and exceedingly bitter, but the Mongols there have become accustomed to drinking it.

Obviously we could not push on farther with the cars. The only way in which we could explore the lake shores was by camel, but our caravan was still more than one hundred and fifty miles away. We had entered the great area of dead sand-dunes, which extends, in an irregular semicircle, from Dolon

Nor on the south almost to the outer Mongolian frontier. The strata of the entire region appear to be Pliocene sediments and doubtless contain rich fossil deposits. I hoped that we might make a camel expedition the next year and explore it thoroughly.

GRAVE OF THE FORMER PRINCE OF EAST SUNIT

Returning next day to the small temple near Koko Nor, we left a Mongol to instruct Tserin to go directly to Hatt-in-Sumu, when he arrived with the camels. Driving southwestward, we came to a large temple, near which stands an elaborate shrine built in Mohammedan style. It bears a golden crescent on the summit but has a Buddha inset! Mongols told us that it was the grave of the old prince of East Sunit. The new, ruling prince, as we had been told at his village, was present at the annual celebration at his temple, Gosho-in-Sumu, not far away.

GOSHO-IN-SUMU

We found the temple, Gosho-in-Sumu, backed up against a high bluff, in the bottom of what evidently had been an enormous lake during Pliocene times. A shallow pond occupied a part of the depression, which was filled with yurts and tents of visiting Mongols. The prince himself was engaged at a ceremony in the temple, and, as his retainers told us that it would not end until evening, we decided to go on. Near his pavilion-like tent stood the usual high, two-wheeled cart, with the wheels far behind the body. This type may be used only by a prince.

From an obo on a headland behind the temple, we continued cross country, eventually reaching a small lake in a beautiful green meadow. All of us were tired because of the heat and rough traveling, so we camped. After a bath in the shallow water we felt much happier. Not far from the tents was a considerable exposure of red sediments, but they were almost barren. Two hours of search next morning revealed only a few scraps of bone. Still, it was enough to convince us that the deposits were Pliocene, of the Tung Gur formation.

HEAVY SAND WEST OF GOSHO-IN-SUMU

Far to the south we could see a big, red escarpment, but a Mongol told us that it would be difficult to reach because of intervening sand. He said that from a monastery, which we could just see with the field-glasses, there might be a trail that would lead us to the exposure.

It was exceedingly hot and we needed drinking water badly, so we headed for the lamasery. The Mongols were terribly frightened, and the well was full of extraordinary red crustaceans. We could get little information from the

EXCAVATING THE SKELETON OF A RHINOCEROS AT MASTODON CAMP, 1928.
This animal evidently had died in a stream-bed.

PLATE XCVI.

FILLING THE EXPEDITION'S WATER-BAGS AT A DESERT WELL, 1928.

terrified priests, but a trail leading toward the distant escarpment gave us some hope. It ended, after ten miles, in heavy sand and disappointment for us. Another trail, going west, we thought might offer some hope, but at the end of fifteen miles it led us directly into a sand-wash, where my car, in the lead, was badly stuck. The trail was above a "blow-out," or wind-hollow, in the bottom of which was a well of excellent water. It was uncertain where we should find the next water, so I decided to camp, as it was already five o'clock.

ARTIFACTS WITH BONE, AT CHILIAN HOTOGHA

Our tents were pitched on the edge of the depression, called Chilian Hotogha. Thomson, while prospecting along the bank almost below my tent, saw some artifacts. Investigating, he found that it had been a great Dune Dweller residence site. Hundreds of artifacts were scattered about and, best of all, bits of bone were discovered *in situ*. This was the first of the Dune Dweller stations where bone was found.

CHAPTER XXXIX

END OF THE 1928 EXPEDITION

PROBLEM OF THE DUNE DWELLERS

We spent that evening, August 3, and all next day prospecting the Dune Dweller station, which lay so conveniently close to our camp at Chilian Hotogha. Right in the middle of the path which led down to the well, an ancient hearth was discovered. The earth, fire-blackened and hardened, was unmistakable. On the hearth itself we found frog and bird bones, and in the immediate vicinity what evidently had been a necklace of fox canine teeth, neatly drilled. Also, small fresh-water clam-shells were drilled and had been used in a similar way. Bones of wild asses, hares, gazelles and many birds were discovered. Some of the larger bird bones were decorated with parallel lines, beautifully etched. There was not a trace of human bones. Metates, pestles, scrapers, hammer-stones and arrow and spear points were numerous. There was also much broken pottery, which evidently had been made by molding the wet clay in a basket.

In the vicinity other accumulations of artifacts were found, showing that this must have been the site of a considerable village. It was quite the most important station that we had discovered.

It is most surprising that no human remains have been found near any of the Dune Dweller stations. Evidently the conditions were not proper for the preservation of bone, or we should have discovered many animal remains. These people subsisted largely upon game, of course, and hundreds of thousands of animals and birds must have been eaten, yet, except for this one spot, no bones have been discovered. It is entirely probable that their dead were buried at some distance from their village sites.

Although the Dune Dweller culture is somewhat similar to the Azilian of Europe, it differs from the Azilian in many important ways. It appears to be distinctly Gobian, and not closely related to any known cultures in other parts of the world. Where did the Dune Dwellers come from and where did they go? Only extended explorations of contiguous regions can give an answer to these questions. What the Dune Dwellers looked like, we do not know. That they

were hunters, there can be no doubt. Certainly they dressed in skins, for Mongolia was cold in winter even then. However, the climate was very much less arid, and the Gobi was by no means such an inhospitable desert as it is to-day.

The Dune Dwellers could not have lived in caves, for caves are virtually non-existent in Mongolia. They must have built shelters out of skins on the sunny sides of banks or dunes. The roots of the tamarisk and other stiff vegetation offer obstructions to the wind-blown sand, and about them dunes are formed. Almost every Gobi lake has dunes on at least one side. Probably these people chose such spots as permanent camps, for there they had the essentials of life—fuel, water and comparative shelter. In remains of the very earliest stage of their culture, we found no arrow or spear points. Presumably they made them of bone, which has not been preserved. In later deposits small, beautifully worked arrow points were found.

We have already found many great residence sites of these people in Mongolia. Of course, there must be hundreds yet undiscovered. At first we thought that they were few in numbers and had a limited distribution. Now we know that the opposite is true. *Twenty thousand years ago Mongolia was much more densely populated by these Stone Age people than it is to-day by Mongols or probably has been during historic times.* Even when Genghis Khan conquered much of Asia and of Europe, it is doubtful if he had half as great a population from which to recruit his armies as existed in Mongolia when the Dune Dwellers lived.

We have explored most of central and southern Mongolia, and everywhere we found traces of this culture. Probably the Dune Dwellers were grouped in communities where living conditions were most favorable, and made excursions of short duration into the more arid parts of the desert. Certainly they were a hardy people of considerable strength and endurance. No weaklings could have lived in such open country, under the semidesert conditions and severe climate. Hunting was difficult then, as it is to-day. Great skill in stalking was required even though game was abundant. Gazelle and wild ass probably formed their principal food, supplemented by smaller animals, such as wolves, foxes, hares, badgers, kangaroo rats and other rodents. In the mountains they could get ibex and wild sheep. As, undoubtedly, some of the country was sparsely forested, wapiti, roe deer, bear and perhaps moose were to be had. Birds they could catch in nets and snares, but to obtain such food they must exercise a good deal of intelligence and skill. That in the later stages, the true Neolithic, they had a certain vegetable diet of sorts, we were surprised to learn by finding grinding stones and rollers. They may have used these to break up roots and seeds, but it is possible that certain kinds of wild grain then grew in Mongolia, under the more favorable conditions.

We discovered but few traces of art. That is to be expected from a plains-living people. Art was developed only during the period of cave life, when there was opportunity for contemplation. Yet, the skill which the Dune Dwellers exhibited in making their artifacts is quite remarkable. Except in a few places, the materials were not good. The Dune Dwellers utilized whatever stone was at hand, and we find implements made of quartzite, chert, chalcedony, jasper and half a dozen volcanic rocks. They could produce the most exquisite flakes, which were used as knives and drills. It is not certain whether they obtained these by steady pushing against a core or by a sharp blow with a hammer-stone. As a whole, their culture is microlithic; that is, the scrapers, knives, drills and arrow points are very small and delicate.

I believe it is improbable that the Dune Dwellers were directly ancestral to the tribesmen who inhabited Mongolia before the present Mongols. It is more likely that they left the country, as the increasing aridity converted more and more of Mongolia into an inhospitable desert. Lakes and rivers began to dry up and the scanty forests to disappear; game became less abundant; in short, the Gobi basin became an impossible residence for any primitive people. They were forced to migrate and migrate they did, carrying their culture to new lands. Thus it might easily have reached Europe. I have remarked that geological evidence appears to place the Dune Dwellers as considerably older than the Azilians, their nearest cultural representatives in France and Scandinavia. This is my personal opinion. The facts yet remain to be demonstrated.

THE SAND-DUNE AREA NORTH OF DOLON NOR

On Sunday, August 5, we left the Dune Dweller camp and visited the sand area, going northward toward a red escarpment which we could see in the far distance. It proved to be the south rim of the Tairum Nor basin. Although a few bones were discovered, it was not richly fossiliferous. The heavy work in the sand had almost exhausted our gasoline. Since we had purchased all there was at P'ang Kiang we had no other alternative than to start back to Hatt-in-Sumu. It was still early in the season, but we could not work without gasoline. Nevertheless, from our exploration we had learned pretty definitely what sort of country there was in the east, and how to study it next year. I was convinced that the great area of dead sand-dunes, which we had found to extend north from the vicinity of Dolon Nor almost to the Outer Mongolian border, would give us important results. It could be explored only on camels, and I decided to do it in that manner, next year.

RETURN TO HATT-IN-SUMU

Returning to the camp at Tairum Nor, where the great mastodon jaw had been discovered, we continued on a trail which ran southwest. As we had

surmised, it brought us to the Kalgan-Urga road twenty-eight miles north of P'ang Kiang, where we camped. I telegraphed the American Minister, asking him to inform the authorities that we were returning with passports issued by Chang Tso-lin, and to request them to allow us free entry. Arriving at Hatt-in-Sumu at six o'clock, we camped at the base of the ridge a short distance from the mission station. It was necessary to await the arrival of the caravan before we could leave for Kalgan.

SIDE TRIP TO GUL CHAGAN

The Mongols reported a lake to the east on the shores of which were many fossil bones. Eriksson agreed to go with us to visit the locality. We proceeded almost straight eastward, through beautiful rolling grasslands, to a mission station named Gul Chagan. Farther east we spent the night at a beautiful valley in the mountains, where a missionary, Miss Vickland, had a summer camp. It was difficult to believe that we were in Mongolia, for the valley was filled with bushes and low trees. Peony and rose bushes were plentiful on the hillsides, but it was too early for the blossoms. Roedeer were numerous in the ravines. North of Urga I have seen similar places, but nothing like it in the south.

A Mongol, whom Eriksson had sent out to locate the lake where fossils were reported, had returned to Miss Vickland's mission station. From him we learned that the lake was seventy-five miles to the northeast, but in the sand-dunes where cars could not go. He had not been able to reach it, but was going again and would bring back specimens. We raced back to Hatt-in-Sumu, just in front of a black rain-cloud which swept up behind us. Hardly were we in camp before the water poured down in torrents. It would have been very difficult to travel had we not arrived before the cloud burst.

FINAL CARAVAN ARRANGEMENTS

To our delight, Tserin was in camp with the camels. Finding our messenger at the temple near Koko Nor, he had made forced marches according to instructions. It was a full day's job to separate and list surplus equipment, and determine what could be left at Hatt-in-Sumu for the next season's work. That night I paid off some of the Mongols, and told Tserin to start in three days for Kalgan, with fifty camels bearing fossils.

HATT-IN-SUMU TO WAN CH'UAN PASS

On August 11, we left Hatt-in-Sumu, carrying in the cars six fossil boxes that were too large to go by the caravan. The road was unexpectedly dry, and we reached Changpeh without incident at four o'clock in the afternoon. It had become an annual custom of ours to remain there for a big Chinese dinner

and a general celebration, but the town was swarming with soldiers. Every available place was taken, and we had to go on. Going down the Wan Ch'uan Pass in the late afternoon, when we might be caught by darkness, was not an attractive prospect, but there was no alternative. The officials at Changpeh were most courteous for they had received instructions to honor our passports, through the efforts of the American Minister.

INJURY OF HORVATH

The Pass was negotiated successfully, but darkness had fallen by the time we arrived at the bottom. Moreover, it had begun to rain hard. The loess hills four or five miles outside Kalgan were as slippery as grease, and we had the greatest difficulty in getting up with the heavily loaded cars. At one of the worst spots, only my car and Young's reached the top. The doctor's stuck half-way up, and Horvath decided to rope the wheels. The night was pitch black and the rain was falling in torrents. While cutting a piece of rope, Horvath drove the knife blade into his thigh, severing an artery. The blood pumped out in great jets. He would have died in a few minutes had the surgeon's car not been near his own. The doctor's medical case, which he usually carried at his feet, had been put into the load to keep it dry. While Perez tried to press down the artery with his fingers, Captain Hill searched for the case. At last he found it, and the doctor could put a tourniquet about the wound. Horvath was soaked with blood, and very weak.

ARRIVAL IN KALGAN

When we arrived at the barrier where our passports were to be examined, the soldiers made objections on some small technical point, regardless of the fact that they had had definite instructions to admit us when we arrived. The fact that we were well known and had a wounded man made not the slightest difference. They said we must wait where we were until morning. It was time for force and I told them in no uncertain terms that either they must let us pass at once or we would shoot our way through. As usual, they surrendered to the threat, and we went on to the British-American Tobacco house which the agent, Mr. Hartigan, had again kindly placed at our disposal. After Doctor Perez had dressed Horvath's leg and made him comfortable, we bathed and shaved and arrayed ourselves in the clothes of civilization. The next day was spent in preparing for our trip to Peking.

KALGAN TO PEKING BY AUTOMOBILE

When Chang Tso-lin left North China, he took with him all the railway cars and locomotives that he could find. As a result, Kalgan was connected with Peking by a train that ran sometimes once a day, sometimes once a week.

PLATE XCVII.

DUNE DWELLER SITE, 1928.

It was here that bones of animals and many flint implements of these interesting people were discovered.

A. THE SITE OF AN ANCIENT DUNE DWELLER HEARTH.
Re[illegible] bones were found on the hearth.

B. THE EXPEDITION'S CAMP SERVANTS IN FRONT OF THE COOK TENT, 1928.

It was useless to think of getting our motors and equipment to Peking by rail. Either they must remain in Kalgan indefinitely, or we must drive them down. We chose the latter course. Driving one hundred and twenty-four miles does not seem, on the face of it, to be a very serious undertaking. But to drive that distance over a road that was virtually a swamp and through a mountain pass where the trail was designed only for mules and camels, is what we had to do. Only two or three cars had attempted it, and they had been empty. Our cars were loaded heavily.

It was three days before we reached Peking—three days of fighting the road from daylight until after dark. At six o'clock of the first evening the trail led us into a wide, dry river-bed. Suddenly, we heard a roar from the hills to the right and saw a brown flood sweeping out from a narrow valley. In a few minutes a wild torrent, waist-deep, was across our path. To get out was obviously the thing to do. Just before we reached the bank from which we had come, there was another ominous roar, and again we were cut off from safety by a wall of water. It looked distinctly bad. We drove to the highest part of the river-bed, and watched the water slowly rise toward us. Finally I could stand it no longer, and we made a desperate attempt to reach the shore. The first car dropped into a hole, breaking an axle. The next car got through. The third sank hopelessly into the mud. We worked feverishly all night, and before daylight got all but two of the cars across. Then the water began to recede rapidly. Had we remained where we were we should have been all right, but one never knows.

The Nan K'ou Pass, where the Great Wall was built to keep the Mongol raiders out of Peking, very nearly kept us out also. The road was such a nightmare of rocks and boulders that I shudder even now. At any moment I expected to see some of the cars crash. How anything on wheels, designed to travel on a road, could stand the punishment those cars received was beyond my conception. But they kept steadily on, and at last we came out on the road at the foot of the Pass. Peking was only thirty miles away. We passed through the great gate of the Tartar wall at eight o'clock.

TROUBLE WITH THE SOCIETY FOR THE PRESERVATION OF CULTURAL OBJECTS

About ten days after our return to Peking, I had word from Tserin that he would shortly arrive in Kalgan with our eighty-seven boxes of fossils. Immediately afterward a long article appeared in the foreign and Chinese press, stating that the Society for the Preservation of Cultural Objects had directed the Governor of the Chahar district to detain our specimens at Kalgan.

Young and Granger went to Kalgan by the first train. Our camels had been met at the top of the Wan Ch'uan Pass by soldiers, who brought them

into Kalgan. Granger prevailed upon the Commissioner of Foreign Affairs to let the cases be taken to Mr. Larsen's compound where they could be safely cared for. An armed guard of four policemen was stationed over the specimens and our men were not allowed to approach them. In the meantime, the Cultural Society sent out a most infamous article to all newspapers stating that our Expedition had "trespassed upon China's sovereign rights"; that we had "stolen China's priceless treasures"; that we were "spies against the government"; that we had been "searching for oil and minerals and smuggling opium." The American Minister immediately took up the matter, and, with a Secretary of the Legation, I called upon General Yen Hsi-shan's representative, for, although General Yen was in Taiyüanfu, he was in charge of the northwest district.

After a few days Yen sent word that it was a matter to be handled by the Minister of Foreign Affairs at Nanking and refused to have anything to do with it. The Cultural Society strenuously prosecuted their publicity campaign against us, and, as in the case with Doctor Hedin, so intimidated the officials that they did not dare act through fear of being called pro-foreign.

No laws regarding the collecting or exportation of fossils existed in China; we had gone to Mongolia with the consent of Marshal Chang Tso-lin, who then represented the recognized government of North China; our passports were exactly the same as those we had had in previous years and had been obtained for us by the American Legation. The Cultural Society had not the slightest legal or moral right to detain our collections. Nevertheless this did not prevent them from doing so. Before the specimens were released the negotiations had occupied six weeks; we had been caused an enormous amount of trouble and expense, and ill-feeling had been engendered on both sides.

THE ANTI-FOREIGN MOVEMENT

It is difficult for Occidentals to understand the reason for the action of the Cultural Society. In the last analysis, anti-foreignism underlay all the trouble we had then, and later. Anti-foreignism accompanied the increasing nationalistic spirit throughout China; any agitation of whatever character that was directed against foreigners found immediate popularity with the masses. The Cultural Society saw an opportunity to obtain an exaggerated importance for themselves before the public by attacking our Expedition. They had been successful in the case of Doctor Hedin a year earlier and obtained much "face" for themselves. Later they and the official offshoot called the "Commission for the Preservation of Ancient Objects" caused enormous trouble for the Citröen-Haardt Trans-Asia Expedition, and drove the distinguished British archæologist, Sir Aurel Stein, out of Chinese Turkestan.

END OF THE 1928 EXPEDITION

Work in our palæontological laboratory at Peking had been progressing on the six large cases of specimens which we had brought from Mongolia by automobile in August. With the release of the eighty-seven cases in October it continued under the direction of Mr. Albert Thomson. Both he and Doctor Granger spent the winter in Peking to prepare the collections. All the other members, with the exception of Mr. Young, had returned to the United States. I left on October 29 for London, via the trans-Siberian railroad. An uneventful trip brought me to New York on November 29. I spent the winter lecturing and obtaining additional financial support for the Expeditions.

CHAPTER XL

START OF THE 1930 EXPEDITION

CONDITIONS IN PEKING, MARCH, 1929

On March 23, 1929, I returned to Peking via the Pacific. The winter's work on the collection had progressed splendidly. It was almost entirely prepared at one fifth the expense of the same work in New York. Moreover, it had been done more quickly because seven men kept steadily at this one job, which would have been quite impossible in the American Museum of Natural History.

During the winter political conditions had been fairly quiet under the Nationalist party rule at Nanking, but there were rumblings of dissatisfaction from Feng Yu-hsiang. Anti-foreignism was increasingly evident, and I felt certain that we would encounter difficulties in our coming season's explorations.

DEMANDS OF THE COMMISSION FOR THE PRESERVATION OF ANCIENT OBJECTS

Shortly after my return to Peking, Doctor Granger and I conferred with the Commission for the Preservation of Ancient Objects, of which Mr. Ma Heng was again chairman. This committee consisted of Mr. Ma, Doctor Wong, Director of the Geological Survey, and Mr. Liu Fu. The committee insisted upon the following conditions for the continuation of the Expeditions:

Article I. "The Central Asiatic Expedition shall be commissioned by the Committee for the Custody of Ancient Objects to proceed to Mongolia to conduct explorations.

Article II. "That the Expedition shall consist of half each of Chinese and foreign members shall be taken as the fundamental principle in determining the number of members of the Expedition. From each half of the members one shall be appointed as leader of the Expedition.

Article III. "All scientific materials collected, with the exception of the vertebrate fossils, as provided for by Article IV, must be retained in China.

Article IV. "(A) All duplicate specimens of vertebrate fossils obtained or those which are similar to previous finds shall be retained in China.

"(B) As to those which differ from previous finds, but which for research must in fact be shipped to the United States, their shipment to the United States under the following conditions may be considered:

1. "China shall send experts to collaborate whose traveling expenses for the round trip and all other expenses during the period of research shall be borne by the Museum of Natural History.
2. "The American Museum of Natural History shall afford these experts with facilities for independent research.
3. "After the completion of research, these articles in their original form must be shipped back to China. Those articles which must temporarily be retained in the United States for reference shall be clearly marked when exhibited, 'Deposited by the Society for the Preservation of Cultural Objects, Peking, China.' In addition, two sets of casts shall be made exactly similar to the originals and sent to China."

These conditions we could not accept, and after weeks of negotiation the expedition had to be abandoned.

AGREEMENT FOR 1930 EXPEDITION

The refusal of the Chinese to allow the Expedition to continue its work in Mongolia aroused indignant protest throughout the world. This had a certain effect upon the Chinese, and during the winter of 1929–1930 I was able to conclude an agreement with them whereby we could go to Mongolia in 1930. But since they stipulated that all mammals, birds, reptiles and archæological specimens which we collected must be given to them, I decided to do no work except in palæontology, geology and topography. About the time arrangements were concluded, another complication arose. Generals Yen Hsi-shan and Feng Yu-hsiang revolted against the Nanking "nationalists" led by Chiang Kai-shih. The rebels assumed control of north China and tried to establish a government. Fortunately I had many friends in the new régime and they promised me that they would raise no objections to our proposed expedition.

THE 1930 STAFF

I had cabled Granger, Young, and Thomson to sail for China long before arrangements were concluded. They arrived at the end of April. In addition

to Granger, Thomson, Young, and myself of the 1928 staff, arrangements were made with the Chinese Geological Survey whereby Père Teilhard de Chardin joined the Expedition, as geologist. We were delighted to have Père Teilhard as a colleague, for his brilliant scientific attainments and charming personality had endeared him to us all. Dr. C. Z. Garber, of the Peking Union Medical College staff, went as surgeon, and Lieutenant W. G. Wyman, U. S. Army, assumed charge of the topographic work. He came through the courtesy of my old friend, Lieutenant Colonel N. E. Margetts, Military Attaché of the American Legation, Peking. Doctors C. C. Young and S. C. Chang were delegated by the Commission for the Preservation of Ancient Objects as Chinese representatives upon the Expedition. We also had our Chinese assistants and servants of former years. The personnel totaled seven foreigners, twelve Chinese, and eight Mongols. The transport consisted of four Dodge Brothers motor cars and fifty camels. Reverend Joel Eriksson had purchased the camels for the Expedition and I had packed the supplies and equipment.

EXPERIENCES WITH CHINESE CUSTOMS OFFICIALS

On May 18, McKenzie Young went to Kalgan with Liu Hsi-ku and all our food and equipment. This was sent to Hatt-in-Sumu by fifteen carts where the camels were waiting. Young and Liu had a most difficult and nerve-racking experience in getting the supplies out of Kalgan. General Yen Hsi-shan had established numerous tax stations in the city and along the railroad. By means of taxes of every conceivable kind he was obtaining some of the finances to carry on his war. Moreover, the tax officials were doing a bit for themselves on every transaction. Their method was to be surly and disagreeable and to insist upon opening all boxes, so that our men would pay them personal "squeeze" to get the supplies out of their hands. Eight tax stations had to be negotiated in Kalgan alone. Young and Liu were nervously exhausted by the time the carts passed the last barrier, and the Expedition's finances had lost several thousand dollars. I cannot speak too highly of their work.

The Nanking permits, applied for by the Commission for the Preservation of Ancient Objects, actually did not arrive until May 20, and I felt that it would be unwise to leave without them, even though they were valueless at the moment. If Yen Hsi-shan were not successful in his revolt, the Nanking documents would be most necessary.

On May 23, Young and Liu took the four motors to Kalgan by train and spent the three days until our arrival on the 26th in obtaining the necessary permits to leave the city. One item was three hundred and twenty dollars merely for permission to run the cars over the road.

Young and I spent the night after our arrival at the British-American Tobacco Company with the manager, Mr. Richard Smith, who most generously put himself and his house at our disposal during the entire summer. The other members of the staff slept in the compound of our old friend, Mr. F. A. Larsen.

During the past year, since Yen Hsi-shan's Shansi troops had occupied the Kalgan area, the taxes had become so exorbitant that trade had virtually ceased. The merchants were powerless to remedy conditions, even though it was evident that Yen was "killing the goose that laid the golden egg." The cessation of trade worked to our advantage in the one fact that the road up the Wan Ch'uan Pass was excellent. Chinese carts with their spike-studded wheels quickly ruin the best road, cutting it into deep ruts. Camels, on the other hand, smooth it out by the tramping of their great flat pads.

We left Kalgan at eleven o'clock in the morning of May 27, and at four o'clock in the afternoon had unloaded our cars in the motor inn at Changpeh. The soldiers at Changpeh asked us for every possible passport and tax receipt, hoping that we might lack some document that would give them an excuse to demand "squeeze." Balked at every turn, at last they triumphantly announced that we could not proceed unless we had permits from the Nanking government. Since they were at war with Nanking and would not have recognized their passports in any event, this was too absurd. A considerable crowd had gathered in the courtyard to watch proceedings, and when I produced our Nanking *huchao* the bystanders roared with laughter. The soldiers lost so much "face" over the proceedings that they retired precipitously, leaving us in peace.

CHANGPEH TO HATT-IN-SUMU

At seven o'clock the next morning we drove out of Changpeh. The city had recently been enclosed within a new mud wall built upon the ruins of the ancient structure and at that time had a garrison of five hundred soldiers. These gentry patrolled the country in sufficient numbers to discourage brigandage. At no time during the past five years had the road been so free from bandits. As a result the Chinese farmers were again occupying the country and building many new mud houses. The road was so smooth and hard that we averaged twenty miles an hour even though the cars were very heavily loaded.

Ten miles south of Chap Ser in the Tabool Hills, we saw four antelope. I have not seen antelope so far south in many years. Another herd of eight appeared fifteen miles farther on and I shot three for camp meat. I suppose they had wandered down into the cultivated area because the bandits since 1928 had prevented any but the most determined farmers from tilling their fields.

The trip to Hatt-in-Sumu was made quickly and without event. Arriving at four o'clock in the afternoon, we found our supplies piled near the mission house. To our regret, Mr. Eriksson was to leave in three days for Sweden with his wife and children.

The tents were pitched in the usual place and we had a very jolly dinner. Granger and I were happy to be in Mongolia again. Every article of our personal equipment was in its usual position in the tent, and we had difficulty in believing that we had been away at all.

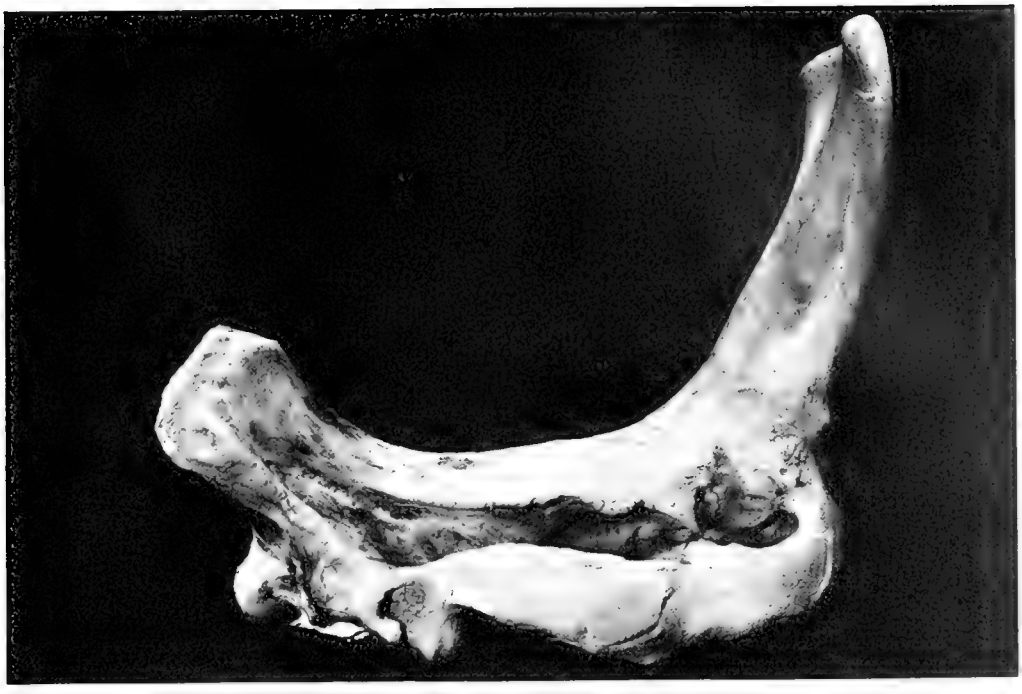
NEWS OF PLIOCENE FOSSILS AT TUKHUM NOR

At the end of the 1928 Expedition, information came to us from native sources of a lake, Tukhum Nor, in the sand-dune region east of Hatt-in-Sumu, the shores of which were said to be covered with fossil bones. At that time I sent out one of Dr. J. G. Andersson's former assistants, a Mongol by the name of Halchin Hu, to investigate the report and bring us specimens. He went on a pony but lost himself in the sand. After wandering with little water and less food he reached a Mongol yurt and returned. He had had more than enough for that year. The next summer (1929) Mr. Eriksson started him off again on a camel and that time he reached the lake. He brought a considerable number of specimens to prove his statements that it was a rich locality. These I sent to New York where they were identified by Granger. He found giraffe, horse (*Hipparion*), rhinoceros and other species, indicating a Pliocene formation. The specimens were so well preserved and the Mongol's statements so enthusiastic that we felt it was a region well worth investigating. From our explorations in August of 1928 it was evident that the sand-dunes could not be traversed by car. Therefore I had organized the 1930 Expedition to travel mostly on camels. It seemed highly probable that we should spend a large part of the summer in the dunes and that we should use the four motors but little.

Halchin Hu was not at Hatt-in-Sumu when we arrived, but he rode in the next day. He reported the lake to be at the base of a gray bluff out of which the bones were weathering; also that he had discovered three other fossil deposits in the vicinity. Although he had reached the lake from the south, through heavy sand, he had returned by a much better route from the northern end. It might be possible, he thought, to take a car within twenty-five or thirty miles of the lake.

Granger and I decided to make a reconnaissance in two cars before we went over with the entire Expedition, even though the Mongol's information appeared to be accurate and was supported by his collection of fossils. We felt that we should like personally to inspect the locality, but we were delayed by heavy rain for two days. It was so cold and damp that all of us donned our heaviest clothes as a strong wind tore ceaselessly at the tents.

PLATE XCIX.



A. SIDE VIEW OF THE SKULL OF THE BATTERING RAM TITANOTHERE, *Embolotherium*.

B. FRONT VIEW OF *Embolotherium* SKULL.

PLATE C.

A. THE EXPEDITION AT "WOLF CAMP."

B. OUR PET ANTELOPE NURSING FROM ITS FOSTER MOTHER, A MONGOL GOAT.

PLEISTOCENE BONES NEAR HATT-IN-SUMU

May 31 dawned bright and clear, with a heavy fog blanketing the plains during the morning. In the afternoon all the staff except Young, Thomson and myself drove to a fossil deposit twenty-five miles away, guided by Halchin Hu. The deposit proved to be Pleistocene and contained but few bones, all badly crushed.

A DUSTSTORM AT HATT-IN-SUMU

At four o'clock in the afternoon we were having tea in the mess tent, when Thomson pointed out a yellow cloud high in the air to the northwest. It swept on at terrific speed, and in ten minutes the plains were blotted out by a curtain of tawny dust. We were only on the edge of the storm and were somewhat protected by the hills behind our camp, but half the tents went down. The wind was icy cold. Between four o'clock and seven the temperature dropped forty degrees.

We speculated as to what was happening to the men who were out in the car. They drove in at about eight o'clock plastered with brown dust. The storm had struck them when half-way back, and even their guide, who had spent all his life in that locality, had lost his way. Suddenly they almost ran into a Mongol yurt. It belonged to old Merin, our former caravan leader. After the wind had dropped a bit he put them on a trail to camp. This was a duststorm, not the usual Gobi sandstorm. The fine yellow sediment had blown up from the cultivated fields of the grasslands and not from the desert itself.

UNSUCCESSFUL ATTEMPT AT EASTWARD RECONNAISSANCE

The next day, Granger, Young, Teilhard, Chang, and I started on our reconnaissance trip to the lake with two cars. After only six miles of travel, we had to turn back because the carburetors and gas lines of the motors had been so clogged with dust from the night's storm that they gave continual trouble.

During one of the waits we saw a wolf kill a sheep. The wolf dashed out from a ravine, separated two sheep and tore open the throat of one while the other stupidly stared at its dying companion. The herder ran into view and the wolf snatched only a few hasty mouthfuls before he loped away. The carcass was left on the hillside. Mongols are superstitious about sheep killed by wolves. Only the poorest natives will eat one. It is bad luck, they think.

THROUGH THE SAND-DUNES TO TUKHUM NOR

Next day, June 2, another start was made. For thirty miles we drove over beautiful rolling hills, east by north. Then very gradually the grasslands

merged into the area of blown sand. The region of contact has a terrain of loose yellow sand thinly covered with long coarse grass. The scant vegetation holds the sand firmly enough so that it is possible, but not easy, to drive over it with a car. In places the grass was entirely absent and the sand so soft that we could get the cars through only by strenuous pushing. For a few hundred yards the motors might labor forward under their own power, only to meet a soft yellow barrier. It was a most desolate country without a sign of life, animal or human. After miles of pushing we entered a basin the floor of which was fairly hard. But it was only a temporary relief, for in front lay another and lower basin filled with loose sand. Far ahead an escarpment was visible with small exposed areas showing pink against the sky.

All of us were pretty well exhausted when we had finally crossed the basin and were confronted with a line of dunes banked against the base of the bluff. It seemed impossible to reach the top of the escarpment, but by almost carrying the cars we got them across the dunes and out of the basin. The upland was extremely rough; still it was hard. A dark felt yurt stood by itself in that vast expanse, emphasizing the loneliness. From a frightened Mongol we learned that the lake, Tukhum Nor, was twenty miles away to the east. Bumping and jolting over "nigger heads" we at last reached the lake. During all the hard work we had comforted ourselves with visions of blue water margined by green grass, of breeding waterfowl and whispering poplar trees. We found, instead, a shallow depression of sun-baked mud, stained by alkali, and surrounded by a waste of sand bathed in streaming heat-waves. To complete the picture, a lone sheldrake sat disconsolately in the center of the basin. Our Mongol could hardly believe his eyes. He had seen the lake just after unusually hard summer rains when the depression was full to overflowing. But that is like most desert lakes—here to-day and gone to-morrow.

DISAPPOINTING NATURE OF THE TUKHUM NOR EXPOSURES

The Mongol pointed to the south side where he had found his fossils. An area of irregular gray hillocks marks the deposit. We plodded across the lake bed, walking on hot sun-cracked mud resembling blocks of gray broken ice in an arctic sea. Halchin Hu triumphantly indicated bits of bone. He seemed awfully pleased with himself about something. "Here are the *lung-gu* (dragon bones)," he gurgled, "many bones, many bones." That gave us pause. So this was what we had pushed our way through miles of sand to see! A dry lake of stinking alkali mud and fossils enough to fill a gasoline box, not more! The knolls, containing the fossils, evidently had been under water not long ago. The fragments of bone were slowly weathering out. But the specimens had been crushed and broken before they were deposited so that we could expect little of interest even if some of the hillocks were excavated. During an

hour's prospecting, a mustelid jaw, bits of *Hipparion* and a few other fragments were the only recognizable specimens. They served to identify the age as Lower Pliocene, Pontian.

As we inspected the exposure, all of us wondered where the Mongol could have found the teeth and bones with which he had enticed us there. He explained that his collection was the result of long search; moreover, that he had taken all the good things. We admitted that.

After a little we began to see the humor of the situation. It was just another experience of native information. We had had sufficient before and might have known better. Still, the specimens he had brought us were distinctly good and there was comfort in having that alibi. It was disappointing, extremely so, but that was about all. Had the entire Expedition wasted time by going there on camels we could not have laughed so heartily. As it was we would push ourselves out of the sand and begin again.

SHELDRAKE BURROWS IN P'ANG KIANG FORMATION

When returning we investigated the pink exposures along the edge of the escarpment which were visible from the basin floor. The region proved to be one of reddish sediments, deeply eroded into ravines and gullies. Not a sign of fossils. Apparently it was an extension of the P'ang Kiang formation. In it Granger and Teilhard found the burrows of two ruddy sheldrakes. The holes were about twelve inches in diameter and they could look in for three feet without seeing the end. The birds flew about their nests anxiously; doubtless they contained young. The nearest water was a small pool in the basin two miles away. The mothers must carry their chicks to water in their beaks.

FOSSIL BEDS NEAR HONGER OBO

When at last we were clear of the sandy area, Halchin Hu guided us to another fossil deposit which he had discovered near Honger Obo. On the beautiful grassy hills there were only a few yurts and herds, and, strangely enough, not a single antelope. The obo is a large structure on the summit of a mountain which dominates the surrounding country. A considerable growth of scrub drapes the sides of the ravines and gives cover for many roebuck. We did not go quite to the mountain for the Mongol stopped at a fossil bed just off the main trail to Gul Chagan. There we found a low rounded knoll, on the summit of which, in the gravel, were a few fragments of *Hipparion* and rhinoceros. As at Tukhum Nor, they had been badly broken before deposition and would be of importance only for identification of the geological formation. Halchin Hu said that all the other fossil beds he had discovered were of exactly the same type.

ABANDONMENT OF THE SAND-DUNE AREA

It was evident from our survey of the country that there is so much vegetation in these southern grasslands that it was useless to expect extensive exposure of fossil-bearing sediments. There has not been sufficient erosion. For an expedition which wished only to list the fossil fauna of the region and work out the structural geology, such deposits are of importance, but for work of our type they were quite useless. Granger and I decided to return to camp immediately, abandon thoughts of exploring the sand-dune area and start northward as soon as possible.

CHAPTER XLI

THE GRAVE OF THE SHOVEL-TUSKED MASTODON

PLANS FOR FURTHER WORK AT MASTODON CAMP, 1930

FROM Hatt-in-Sumu we intended to go north to the region of Mastodon Camp east of Iren Dabasu, where the shovel-tusked mastodon jaw had been discovered by the 1928 Expedition. It was impossible to take all the men in our four cars, so we made up thirty-three loads of gasoline and food for the caravan and stored the remainder at Mr. Eriksson's. Five of the Chinese assistants and one Mongol interpreter were to go with the camels.

REPAIRS AFTER A DUSTSTORM

They could not start until June 6, for we had two days of extremely bad weather. The wind blew a full gale and the temperature dropped to 38 degrees Fahrenheit. It was so cold that all of us huddled in the tents enveloped in fur coats, except Young who had a difficult job of repair work on one of the cars. The bearings of his motor had burned out, due to clogged oil supply resulting from the duststorm of May 31. He built a windbreak of canvas but it furnished little protection. The rest of us gave him moral support, but that was about all that we could contribute in the way of assistance. In order to avoid further trouble, he cleaned the carburetors and vacuum tanks of all the cars. We had never experienced a storm like that of May 31. The dust was so exceedingly fine that it had sifted into the tightest containers. A yellow film had penetrated even into the cameras which were in triple boxes.

EFFECTS OF RAIN IN THE DESERT

June 6 was a beautiful, almost windless day. The caravan left at eight o'clock, but we could not go until the following morning because Young had not yet finished the cars. The rains of the past week had given the desert a new dress. All that had been yellow now was green. The metamorphosis caused by a very little water is one of the most amazing phenomena of the Gobi. The change seems almost magical. Innumerable shoots of vegetation seem to lie dormant, waiting for a few drops of moisture to bring them to life. Small herds of grassland antelope were to be seen all along the road. I shot

four or five of these for meat, and a bustard. The bird's crop was crammed with grasshoppers.

THROUGH AND BEYOND P'ANG KIANG

At P'ang Kiang the telegraph operator greeted us. He had not left this desolate post for four years. Opium kept him contented. Without the pipe it would have been a well-nigh impossible existence. The road was like a boulevard and we made wonderful time to the Irdin Manha escarpment, where our course was changed to northeast.

BULGA-IN-SUMU

Half an hour before sunset the cars were halted at a ruined temple, Bulga-in-Sumu, with a day's run of one hundred and thirty miles to their credit.

It was a windless night, so still that one could almost hear the silence. No tents were pitched, the men spreading their sleeping bags wherever their fancy dictated. As in previous years we found a raven's nest in the old temple and collected two half-grown young for pets. The priests of the small temple, newly constructed and half a mile away, told us that an unusual number of wolves had appeared in the vicinity. Indeed we saw five on the way from Irdin Manha. They were giving the Mongols of the valley much trouble, for a great many flocks of sheep and goats had been concentrated about the small lake where the grass was emerald green.

AGAIN AT MASTODON CAMP

On Sunday, June 8, we pitched our tents on the promontory at Mastodon Camp overlooking the great basin. This Pliocene formation had been named Tung Gur by Doctor Spock in 1928, but at that time we had imperfectly explored it due to lack of gasoline. Our intention was to follow the escarpment both north and south until the exposures ended. It seemed highly probable that along the shore-line of the ancient lake there would be the remains of bogs and quicksands in which animals had been trapped during Pliocene times. Moreover, such deposits would be the most likely places in which to search for primitive human remains. Although primates were more intelligent than their contemporary animals and would avoid such death-traps, accidents happen even at the present day. Men still are caught in bogs and quicksands. We hoped, also, to find river-drift deposits in the beds of ancient streams, tributary to this Pliocene lake.

EXPLORATION OF AN ANCIENT LAKE-SHORE

Young, Teilhard, Granger and I started for a reconnaissance trip to the south the day after our arrival at Mastodon Camp. We followed the shell-

line of the lake-shore, investigating every point where gray sediments appeared. Well out in the basin was an isolated rounded hill. Five minutes after our arrival there, I saw a bit of white bone, about three inches long. I touched it gently with my hand, but it did not move. Dropping to my knees I brushed away the surface soil with a whisk-broom. A flat bone was exposed; then teeth appeared. I knew that I had gone far enough and called Granger. Under his expert manipulation the jaw of a mastodon was soon exposed with the molar teeth and one tusk in position. It was not the shovel-jawed *Platybelodon*, but a round-tusked mastodon. This was a new type for the formation. Leaving it for future removal, we drove to a long exposure of the escarpment which was deeply eroded on the western face. There was much broken fossil bone lying on the surface. On four or five hillocks, vertebræ, ribs and limb bones were visible, embedded in the gray earth. The line followed the shell area of the ancient lake-shore. Almost certainly it marked a former bog or quicksand deposit.

WOLF CAMP

Camp was shifted next day. It was a drive of only eleven miles over the hard gravel peneplain. Just as the cars stopped on the escarpment, a big gray wolf dashed over the edge and across the plain. He had been asleep in one of the ravines below us. I reached my rifle first and rolled him over at three hundred yards.

The tents were pitched on a jutting promontory. A weird panorama of red and gray ravines sloped to the basin floor on three sides of us. Far to the west, the Arshanto escarpment showed as a sheer wall of purple and gold. The plain which stretched away behind camp to the eastward was almost terrifying in its vastness. We knew that for many miles there were neither water nor Mongols. It was not a region to be entered without due thought.

As soon as camp was made, all the men scattered over the badlands, prospecting for fossils. I discovered a mastodon palate having good teeth, and another single molar. While Thomson worked these specimens, Granger went over to the knoll to remove my mastodon jaw of the day before. One half was gone, but the other side, even to the tusk, was perfect.

While prospecting I saw quantities of wolf droppings and tracks, and thirty-two antelope skulls. That night my police dog ranged the badlands barking frantically. Obviously the place was infested by wolves, and we named it Wolf Camp.

WATER-SUPPLY AT WOLF CAMP

It was a beautiful camp but rather far from water. The only well in the vicinity was the one near the trail six miles away, named Gur Tung Khara

Usu. A car went there every morning loaded with gasoline tins and brought sufficient water to last the day. We contemplated digging our own well but there was no geological reason to believe that the water-table was near the surface at any point close to camp.

A MOTHER AND BABY SHOVEL-TUSKED MASTODON

On June 12, I went with Granger and Thomson to try to locate a broken mastodon skull which the former had discovered on the initial visit to this escarpment. Granger always says that the surest way to find a fossil is to lose one. While you are searching for it probably you will discover something else. The paradox proved true in this case. We simply could not locate that broken skull, but a bit of bone caught my eyes, and, brushing away the sediment, I exposed a mastodon's molar tooth. A few moments later Granger removed a flat stone block. It was like lifting a trap-door, for under it lay another great tooth firmly set in bone. Granger followed it down while I looked on, seething with excitement. The enormous spoon-shaped lower jaw of a shovel-tusked mastodon, *Platybelodon*, slowly took shape under his brush. It was five feet three inches in length, and the two flat, plate-like lower tusks measured fifteen inches across. In the meantime, Albert Thomson had determined that the other teeth belonged to an adult female skull.

We were exultant, for there was every reason to believe that the specimens were perfect. What we had found eventually proved to be both skulls, jaws, and parts of the skeletons of a big mother shovel-tusker with her baby. No other bones were there, only those two individuals. We are at a loss to know just why they died at that particular spot. It could hardly have been a bog or quicksand for in that event bones of other animals probably would have been preserved. Perhaps they both fell into a hole, or part of a bank caved in upon them. Whatever the cause, there they had died, mother and baby together. It was a kind fate that had directed our steps to their unmarked grave.

ARRIVAL OF THE CARAVAN AT WOLF CAMP

On the evening of June 12, the camels arrived at Wolf Camp. They had found the distance from Hatt-in-Sumu to be about one hundred and thirty miles on the direct line they took, and some of the trip had been through heavy sand. All the camels were in good condition, and there had been comparatively little leakage of gasoline.

OTHER FOSSILS AT WOLF CAMP

The next morning Granger started all the Chinese collectors at work on the bone-bearing hillocks just below the tents. "Buckshot" discovered there a fine baby *Platybelodon* jaw, and the others got skulls of small carnivores

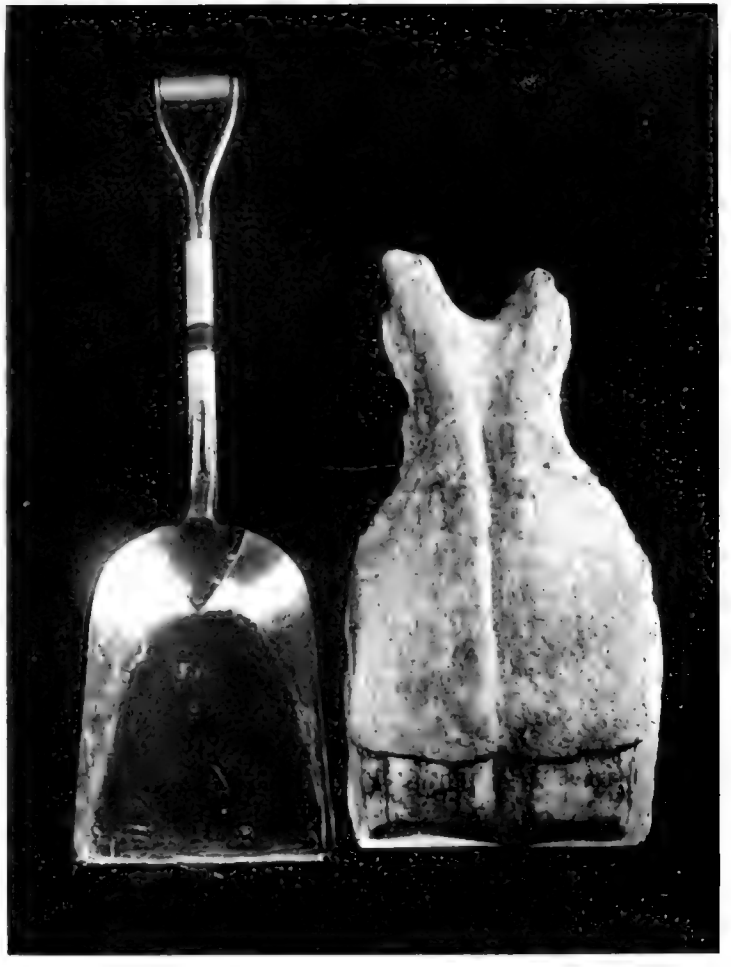
PLATE CI.

A. THE GRAVEYARD OF THE SHOVEL-TUSKED MASTODONS AFTER THREE WEEKS' EXCAVATION.

B. TWO JAWS OF SHOVEL-TUSKED MASTODONS FROM THE GREAT QUARRY.
At the extreme right of the picture may be seen the broad flattened tusks of another pair of jaws

PLATE CII.

A. GRANGER AND THOMSON WITH A SHOVEL-TUSKED MASTODON'S JAW.
This specimen is still in its field casing of burlap and paste.



B. THE JAW OF A SHOVEL-TUSKED MASTODON RESEMBLES AN ORDINARY COAL SCOOP.

and artiodactyls. The bones were mixed in a heterogeneous mass and gave unmistakable evidence that the animals had been trapped in a bog.

RECONNAISSANCE EAST OF WOLF CAMP

On June 19, when the removal of the mother and baby mastodons had been almost completed, Granger, Young, Wyman, Teilhard and I left in two cars for a reconnaissance to the east. We drove across the plain to the well at Tairum Nor, near which we had camped in 1928, passing many small herds of gazelles of both species on the way. From the well we drove eastward along the edge of the escarpment, descended to the floor of the basin and across to a well-dissected bluff of red sediments on the other side. On a jutting promontory stood a large round obo flanked by thirteen tiny obos like a mother with her children. An hour's prospecting did not reveal a trace of fossil bone, but we felt certain that the formation was Pliocene. In this region all the Pliocene red sediments appear to be barren; it is only the gray or yellow strata that are fossiliferous.

Continuing southeast to the "blow-out," where in 1928 we had discovered a fine deposit of Dune Dweller artifacts and bones, we made an attempt to get through the sand to the southern red escarpment which we had failed to reach in 1928. Again the heavy sand barred our way, but with field-glasses we studied the exposure and came to the conclusion that it consisted of more of the red Pliocene sediments. As it did not show a trace of gray or yellow, there was every reason to believe that it would be barren of fossils. Therefore we decided not to attempt to reach it from the south. Returning to the well near the Dune Dweller deposit, we camped for the night.

The next morning we drove north for seven miles to a temple which the Expedition had visited in 1928 and continued on a fine broad trail for about fifteen miles. Much to Teilhard's delight, he was able to identify an exposure of Palæozoic limestones of the oldrock floor. Turning east from the trail we descended into a broad valley and drove for some distance across a range of low hills. The going became so rough that we had to drop back again into the valley to a small trail going north. We had made only forty-five miles before tiffin, due to frequent stops for geological investigations and Wyman's topographic work. The whole region was disappointing from a palæontological standpoint, and further explorations to the north and east indicated that we could hope for nothing better in that direction for a long distance. Eventually we turned west into the area which had been explored in 1928 and reached camp late in the evening.

A DEATH-TRAP FOR SHOVEL-TUSKED MASTODONS

Just before our departure on this two-day reconnaissance, Teilhard had prospected the escarpment south of Wolf Camp. Six miles away he dis-

covered an amphitheater in the badlands, capped on the western side with snow-white marl. The slopes of the familiar gray sediments were strewn thickly with broken mastodon bones—teeth, fragments of skulls and limbs, vertebræ and dozens of ribs. In a rectangle formed by four blocks of sandstone, part of a jaw was embedded.

The fragments were confined to an area about thirty by fifty feet. There was every indication that it had been another death-trap. We began work with the keenest anticipation immediately after our return. Still no one suspected that we were about to excavate what will go down in history as one of the world's most remarkable fossil deposits. The first day's work demonstrated beyond question that this was the site of a former bog.

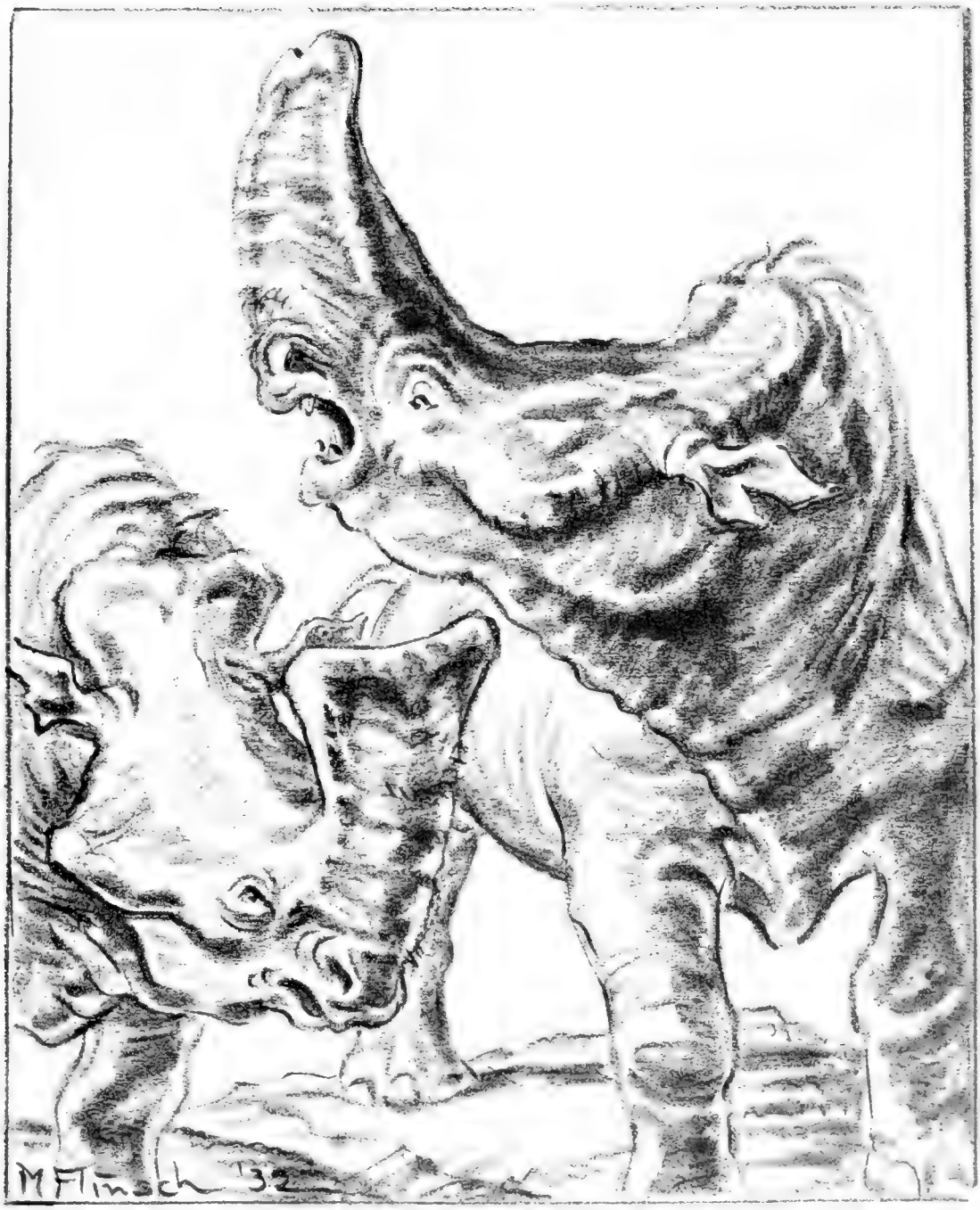
I wish that I were able to give an adequate impression of the thrilling interest in opening this ancient grave. Only a great writer could do that. Out there in the desert in the brilliant sunlight of the year 1930, we were reading the story of a tragedy enacted millions of years ago. Every hour, at first every few minutes, a new page was turned in this book of stone. Reconstructing the picture is what fascinates me! We may not get all the details correctly, but the main facts are there. It is not theory but truth. We know what happened. The tale we read is as follows:

A quiet estuary ran inland from the main lake. Lush vegetation lined the shores. Floating plants and green tubers sent their roots downward through the shallow water into a bottomless well of mud. A huge mastodon, his monstrous shovel-jaw dredging up masses of trailing grasses, worked his way slowly along the shore. The succulent vegetation resting so innocently just beyond the water's edge enticed him farther and farther into the treacherous mud. Suddenly, amidst his greedy feeding he found that he could not lift his ponderous leg. He struggled madly only to sink deeper and deeper into the mire of death. Frenzied trumpeting echoed from the high shores. At last it ended in exhausted gurgles as the colossal beast sank below the surface.

Another came and still others, each one to die as he had died. Twenty, we know, were trapped; probably many more than that. Down in the black mud tons of flesh macerated and dropped away from the great skeletons, leaving the bones to separate one by one. Some were crushed or broken when other victims piled upon them; some remained as perfect as when they bore the living flesh. Perhaps at last the death-trap was full to overflowing; perhaps the water, fouled by decaying flesh, sickened the vegetable life and left the trap unbaited; perhaps the estuary itself dried up. Whatever the immediate cause, we know that as centuries grew into thousands of centuries the great lake disappeared. Countless tons of sediments were deposited on its dry floor. The mastodon's unmarked grave was buried deeply, hopelessly lost.

Then came a change of climate. Gradually the winds of the Ice Age

PLATE CIII.



THE BATTERING RAM TITANOTHERE *Embolotherium grangeri.*
Restoration by Margret Flinsch.

PLATE CIV.

THE SHOVEL-TUSKED MASTODON *Platybelodon*.
From a model by Margret Flint.

removed the sediments in the old lake bed. Particle by particle they were swept high in the air to be dropped upon the plains of China, three hundred miles away. It goes on to to-day. The desert is still giving up its surface, being worn down by the unceasing Gobi winds. Thus it has been eroded for perhaps a million years.

In our search for the hidden stories of nature we found the mastodon's grave in that long-dry bog. But we came half a century too late. Already the upper part of the deposit had been worn away by wind and water which destroy exposed bones as they destroy the rocks. Still, much remained. When we removed the upper cover of sand, a mass of fossil bones was disclosed in a thick lens of green clay. They lay like a huge pile of jackstraws. Great scoop-jaws, many of them nearly perfect, were heaped upon each other in every possible position. Some extended straight down; others at oblique angles; still others almost horizontal. Most of the jaws were more than five feet long.

BONES FROM THE CROWDED GRAVE

The part of a jaw which we discovered in 1928 had been enshrined with reverence as one of the prize exhibits of the Museum. Here we had half a dozen complete specimens visible at one time and doubtless many others at the bottom of the pit. Mixed with them in a seemingly hopeless jumble were enormous flat shoulder-blades, pelvic bones, limbs and scores of ribs.

It was difficult to remove any bone, for usually it lay under several others. Only by finding the topmost ones could work begin. The bones themselves were poorly preserved. They were like chalk and impregnated with mineral matter only to a comparatively small degree. Walter Granger and Albert Thomson with their five trained Chinese assistants did all the work. The rest of us were only too eager to help but we did not fit in. After I had dug into a jaw, Granger politely suggested that I cease operations. I retired to the outskirts where I could watch excavations and drift in fancy back to the days when it all had happened. Doctor Garber fared better, for with his surgeon's temperament and technique, he became not only an accepted but sought-after assistant.

The bones were so soft that as soon as a portion had been exposed it must be soaked with shellac. Thus hardened, more matrix could be removed and more bone exposed. Next, the entire surface was covered with Japanese rice-paper and gum arabic. The paper and gum cemented in place any loose particles and strengthened the specimen. When the entire bone was laid bare, it was covered with strips of burlap soaked in flour paste. In a few hours the paste had dried and the bone was enclosed in a hard shell. Then it could be turned over, pasted on the other side, and packed without fear of damage.

It must not be imagined that the work of excavating the deposit was finished in a few days. Six weeks the men worked there. The hole assumed gigantic proportions. It was amazing that we did not find more skulls intact. Only three were removed, and they were those of big bull mastodons. But twenty-five ivory tusks were taken out. We wondered why such comparatively slender bones as the five-foot jaws had remained unbroken when the skulls were destroyed. Still, an elephant's skull is by no means the solid mass which it appears to be. The walls are filled with air-chambers, and the skull is like a gigantic honeycomb. Probably they could not withstand the pressure and suction of the mud.

Fifteen great scoop-jaws were recovered and half a dozen broken pairs, and virtually all the other important bones of the skeleton as well. There is very little that we shall not know about the anatomy of this amazing creature when the material has been studied.

CHAPTER XLII

WOLF CAMP

ROUTINE WORK

LIFE at Wolf Camp settled into a delightful routine when we began the intensive excavation of the mastodon quarry. Breakfast over, Granger, Thomson and Garber, with our Chinese assistants, drove to the pit carrying their tiffin. "Buckshot" and two other Chinese had erected a tent and lived there in order to prevent wandering Mongols from disturbing the exposed fossils. The palæontologists remained at the quarry all day, hard at work.

Teilhard de Chardin with either Young or Chang drove about the surrounding country making geological inspections. The long stay at this camp gave Teilhard de Chardin an opportunity, such as our geologists have not had on former expeditions, to study intensively unsettled problems of formation contact and relationship.

Lieutenant Wyman was busy mapping the region of Wolf Camp. Whenever we made a reconnaissance in any direction, he included it in his survey, thus gradually enlarging his map to considerable proportions.

McKenzie Young had some job to do upon the four cars almost every day. This was the third season in Mongolia for all except one of the cars, and the rough going had taken its toll. It was only by constant care that Young kept them up to the standard which safety in the desert required. They had done marvelous work for us under the most trying conditions, and it was really too much to ask of any machine to take them back into the Gobi.

As for myself, there was always something interesting to do. Once or twice during the day I drove to the mastodon quarry to see what new specimens had been exposed. Often I would spend several hours in the vicinity prospecting new corners of the badlands. Wherever the shell-layer of the ancient lake-shore appeared, there one could always hope to discover fossils.

THE FRESH MEAT SUPPLY

Every other day the camp needed antelope for meat. Lieutenant Wyman and I would start out in the small car. Almost any direction would do. We were sure to find antelope within a few miles. The car has a strange attraction

for all animals, wild or domestic, and almost always antelope will try to cross in front. Running toward them diagonally we could entice them toward us as a magnet draws steel. A wild rush at full speed across country, rough or smooth alike, a sudden stop and leap to the ground on either side; two or three shots from each man; usually two antelope. That is how we went to market. We seldom shot under two hundred and fifty yards, and the animals were running at fifty to sixty miles an hour. It really is not as difficult as it sounds. Often sportsmen have said to me, "You could hardly see an antelope at four hundred yards, to say nothing of shooting it."

But they do not know Mongolian conditions, where crystal clear air, a flat plain and gazelle running smoothly in a straight line make easy shooting. If the animals only knew enough to dodge about, we would not get half as many. The first shot usually gives the range, for the bullet always kicks up a spurt of dust. After that one ought to score with the second and third and sometimes the fourth; then they are beyond range. Often we have loaded the car with three or four gazelle after only one race. It is not sport, that is true. But we are after meat. Twenty-five men in camp eat an astounding amount. Personally, I had much rather go to a market and buy my meat across the counter. I have killed too many gazelle—perhaps a thousand—and it has ceased to be fun. I knew exactly how well I can shoot, and the only satisfaction I get is in making a clean kill so that the beautiful animal does not suffer. If it were possible I would not shoot a single one, but it cannot be helped. New men always get a tremendous thrill out of hunting antelope, and it surely is exciting at first. I have had too much of it, that is one reason. The other is that now I am not keen to kill anything except dangerous game. Hunt a tiger on foot and he has a chance to strike back on more or less equal terms!

LOST ON THE PLAINS WHEN HUNTING WOLVES

One morning the cooks shouted that a pair of wolves were only a short distance from camp. I jumped into a car with two Chinese. The wolves were heading straight for the center of the plain where the going was rough. The car could do only twenty-five miles an hour and the wolves a little better than that. They pulled away from us slowly until we found a stretch of hard gravel. At forty miles an hour we overtook them and I got in one shot at nearly four hundred yards. The rearmost wolf dropped flat. Rushing past him we followed the other which had a long start. He twisted and turned, always seeking the roughest ground. After five miles I got a bullet into his quarters but he kept going. For twenty miles we followed that wretched wolf. He would disappear over a rise and lie down in a ravine or behind a stone. After we had passed he would try to sneak out unseen.

Finally we lost him when the car was stopped by a sand pit. Then I looked about to see where we were. I could not tell because the sun was obscured by heavy clouds. The horizon was a flat line, except where patches of mirage piled up visionary mountains. There were no more landmarks than at sea.

Mentally I tried to reconstruct our course. I had a feeling that we had traveled generally southeast, but in the excitement of the chase I could not be sure. The gasoline tank registered five gallons. Half a bag of water hung on the car, but the radiator was nearly dry. My compass was not where it should have been, in my pocket.

Following our tracks backward netted nothing, for we soon lost them on a wide stretch of gravel. We could only travel blindly in the direction where I thought camp ought to lie. The flat horizon line continued to be flat no matter how far we went. Now and then I steered toward what I thought was a promontory, only to see it stream off in the vague lines of mirage.

The situation was uncomfortable but not serious. If the gas gave out before we reached camp, we should just have to sit and wait. Fortunately I shot an antelope. That would give us something to eat and we could drink the water from the radiator. I knew that eventually the others would find us. It hardly seemed possible that they would be worried enough to search until late in the afternoon. In camp they would think that we had joined the party at the fossil pit, six miles south. I would get the car to the highest ground and when night came turn the spotlight on the sky. Such a ray can be seen for a long distance.

These thoughts were going through my mind as we bumped our way across the plain. Strange how much rougher it seemed than when we had the wolf in sight. Perhaps I was all wrong and we were going in the opposite direction. I could only trust my instinct. There was absolutely nothing in the landscape to give a clue. We traveled for two hours. The speedometer registered thirty-five miles. There were two gallons of gas left. That would give us only twenty miles in the rough going.

A little later my eye caught a small patch of gray sediment lying on the prevailing red earth. I stopped and examined it carefully. There was no doubt that it was the fossil-bearing clay of our deposits. There was none of the gray sediment on the eastern side of the plateau. Therefore we must be going in the right direction, west. Only a gallon of gasoline remained, but my worries had gone. Although the plain appears to be absolutely flat, it really is not. It rolls away in great undulations like the long smooth swells of a calm sea. From the crest of a land-wave, I saw eleven blue masses swimming in the heat waves of the desert. They rose and sank, floated uncertainly in the light breeze and finally settled to earth as we approached. It was our camp, three miles

away. There was still a little gas left when we drove in, but only a little. Another four miles would have consumed it to the last drop. That indefinable direction instinct which all explorers develop had taken us home as surely as a compass. We often marvel at the direction instinct of animals. To me it does not seem at all strange. That sense is much more highly developed than in man because they have to use it constantly. Mongols have it to an amazing degree—much more than any white man. They use it every day. Without it they never could exist in the Gobi!

THE ABUNDANCE AND ACTIVITIES OF WOLVES

Just after my experience on the plain, Young and Albert Thomson got a she-wolf which had ventured almost into camp. The cooks saw her at daylight and called the men. My police dog, who had been ranging the badlands all night, barking himself hoarse, realized that it was a time to exercise discretion. He persistently gazed in the opposite direction when the boys tried to show him the wolf, but his violent trembling showed that he had seen it. He had important business elsewhere when the carcass was brought into camp.

Our caravan Mongols had taken the camels down into the basin where the feed was better than on the plain. One of them came up, badly frightened, for a wolf had bitten a girl in the thigh when she tried to drive it away from a freshly killed sheep. He was worried about the camels. Young went down next day and found thirty sheep lying about with their throats mangled. Three wolves had rushed into the flock and almost annihilated it in a few minutes.

In the western Gobi, wolves are remarkably scarce considering the abundance of game. There, we seldom shot more than four or five in an entire season. At this camp someone got a wolf almost every day. One of the Chinese surprised a pair with two young ones some distance from their den. The mother seized one of the babies, about the size of a cat, in her mouth and made off with it down a ravine. The other ran back into the den.

A BABY GAZELLE AS A CAMP PET

One morning the caravan leader found a baby gazelle on the way to camp and brought it to us in the sleeve of his coat. It was only a few hours old and seemed all wobbly legs and ears, but yet it could run faster than a man.

Lieutenant Wyman took it under his care. He already had three sandgrouse, two ravens, four falcons and a hedgehog. We called his tent "the zoo." I sent the Mongol back to buy a milch goat and its kid. But the goat would have none of the antelope, neither would the little fellow nurse from his foster mother. For days Wyman kept it alive by forcible feeding, injecting the milk with a rubber syringe. Every two hours all through the night and

day he religiously did his job. Then suddenly the little fellow seemed to discover the goat. He nursed voraciously but his legs were so long that he had to kneel to get his dinner. Wyman placed two stones at proper intervals, grasped the goat by horns and tail and hoisted it to the pedestal. All went beautifully then and the feeding was delegated to Bato, one of the Mongols.

When the kid was taken away from the goat she adopted the antelope without reservation. The strange pair were inseparable. They wandered over the desert together but never strayed far from camp. A sudden fright would send them full speed for the cook-tent. It was interesting to watch the gazelle when an unknown Mongol appeared. He would seem to sink into the ground. Only with difficulty could one discover him lying flat beside a sagebrush, head and neck straight out. His gray-yellow coat blended perfectly with the gravel desert. When the Expedition left Mongolia in October, Granger gave the goat and the antelope to the missionaries at Hatt-in-Sumu.

A VIOLENT STORM

On June 23, about seven o'clock in the evening, heavy clouds began to pile up in the north. Then a storm began that was as near a typhoon as I have ever seen in the Gobi. Floods of rain and a seventy-mile wind. We spent a miserable night, for tents went down on all sides. One moment we lay snug and warm in our fur bags. The next we were enveloped in a sodden mass of billowing cloth, fighting madly to get out. Paddling about half naked in a freezing rain in the middle of the night is either tragic or funny. We chose to believe that it was funny. Because everyone else was in the same mess it made it easier to see the humor.

One by one we straggled into the cook-tent for breakfast. It was a veritable mud-hole, but the boys managed to prepare a decent breakfast for us. The rain continued until ten o'clock in the morning, when suddenly the clouds broke away and in twenty minutes there was nothing about us but blue sky. But at three o'clock in the afternoon the clouds gathered again and by six it was raining hard. That night we witnessed an amazing sunset. All the sky was solid clouds except a clear streak in the west just above the horizon. Suddenly the sun blazed out in a flood of yellow light through the pouring rain. Great double rainbows, complete arches, in the east remained until the sun dropped below the horizon rim. Even though our camp was on the top of the escarpment, the surrounding ground was a veritable bog.

LOSS OF THE ALCOHOL SUPPLY

When we began to sort out our effects the next day, we made a tragic discovery. During the gale the edges of the mess-tent had been weighted with whatever was handy: stones, boxes, saddles and bags, anything to keep

it down. To our intense chagrin we found that one of the cases had contained ten gallons of alcohol, all we had. It was gone, every drop. Leaked out through a tiny hole in the side. That situation did not strike us as being at all funny.

The mastodon bones in the great quarry were like chalk and could not be touched until they had been hardened with shellac. The shellac of course must be cut with alcohol. Work must stop unless we could get more alcohol. It meant going to Peking. Fortunately that was only four hundred miles. Had the loss occurred during any of the other expeditions when we were a thousand miles out in the desert, it would have been ruinous.

McKenzie Young and I were obviously indicated to do the trip. We were not keen about it, for the life in camp was fascinating, and Peking in July is like a blast-furnace. Since it had to be, I decided to take two cars and load them with specimens. A full-sized war was going on not far from Peking and Mongolia might be cut off by retreating soldiers at any time. The more fossils that were safe in headquarters, the happier we should feel.

A TRIP TO PEKING FOR ALCOHOL

Packing the specimens required several days, and it was June 30 before we left with eighteen cases of fossils. Driving away from camp just as the sun was rising, we cut straight across the desert to the main Kalgan-Urga trail. The vast flat plains were glorious in the cool morning air. Hardly ever were we out of sight of gazelle feeding singly or in herds. Bustard and demoiselle cranes circled like aëroplanes beyond the cars. Always there was something interesting to one who could read the book of nature. Once on the main trail we kept a keen watch for bandits. They might take pot-shots at us from behind the hills. But the road was free that trip and we drove steadily mile after mile for fourteen hours.

We reached Kalgan at five o'clock in the afternoon of the second day and were allowed by the tax officials to take our boxes to Mr. Larsen's compound. This had been arranged by our Chinese Liu Hsi-ku after passing out generous "squeeze." Young remained in Kalgan to bring down the cases by train. He had to ride with them in the open freight car with an assortment of pigs and chickens, and at almost every stop give from two to ten dollars to the station master to prevent the boxes from being taken off. The Chinese had arranged a splendid system—for themselves. No "squeeze," no freight.

Through the courtesy of Colonel Breckenridge, commanding the U. S. Marine Detachment of the American Legation, a military truck with uniformed soldiers met us at the station. The boxes were quickly transferred to the car and went through the gate without question, thus avoiding certain trouble with the tax officials.

On the Fourth of July, McKenzie and I duly presented ourselves at the Peking Club reception. Gossip buzzed. Why had we returned so suddenly? When I told them that we came for alcohol, a roar went up. "We thought you were non-drinkers in the Gobi! That's too thin! What is the real reason now? Just between friends; you know that we'll keep it quiet."

No one would believe the truth. Peking is like that. It scents a mystery, a romance or a scandal in the simplest things. So we let it go.

I gazed with satisfaction at the eighteen cases of fossils that reposed in our big laboratory. If war prevented us from getting the rest of our collection to Peking, at least that much was safe.

RETURN FROM PEKING TO WOLF CAMP

A week later we were on the trail again driving hard for camp. At eleven o'clock in the morning we reached the Black Water, a treacherous swamp, the worst place on the road. Three times in a quarter of a mile our car broke through the thin crust and went down to the axles. Only by sinking a foundation of stones and wood in the seemingly bottomless mud and lifting the car with the jack could it be extricated. For seven hours we worked feverishly. At this place there are a few scattered Chinese villages of dubious reputation. More than one car has been robbed when mired and helpless. At least fifty people were clustered about and we felt sure that if darkness found us there we should have a lively night. In daylight we were safe enough, for both of us wore heavy revolvers and kept rifles at hand even when working at the jack.

By six o'clock we had passed the swamp and were again on the hard trail. It began to rain, first in showers, then in a steady downpour. Darkness came at eight when we were opposite Chap Ser, the most dangerous place in all Inner Mongolia. It is a collection of Chinese mud huts and Mongol yurts at the extreme outer edge of cultivation. Bad characters, both Chinese and Mongol, gather there and for years it has been a veritable bandit stronghold. Even though we faced a cold, wet night there was no question of seeking shelter at that place. We drove past at full speed, while hard-looking natives stood in groups, glowering.

Twenty-two miles beyond Chap Ser were the yurts belonging to our caravan Mongols. If we could find them in the darkness there would be a dry shelter for the night. Driving over a bad trail in the inky blackness of a rainy night has its difficulties. It was half-past ten before the speedometers registered twenty-two miles. We held a consultation. The yurts ought to be a half mile off the trail if we were right. We turned abruptly eastward and bumped over the rough sagebrush hillocks. Suddenly a dog barked, then a flicker of light. We had arrived at the middle of the village, but what a panic! Men and women ran out half-clothed screaming in fear. They thought

we were bandits. It was ten minutes before they could comprehend who we were. Then Bato's wife cleared her baby and herself out of the best yurt and brought tea and Mongol cheese. Young and I slept like dead men while the rain poured outside.

At five o'clock the next afternoon we ascended the escarpment to the flat plain. Two miles from camp a lone wolf trotted out of the west to his nightly hunting-grounds in the basin. He looked huge and gaunt in the slanting sunlight. Puzzled by the cars, he loped slowly away, head turned over his shoulder. I took one shot and he went down stone dead. That was number thirteen for Wolf Camp.

The men were all out to meet us when our cars roared up to the tents. First I had to hear what they had found in my absence; then we told them the news of China and produced letters and papers. It was July 14, Bastile Day of France, and dinner that night was in honor of our colleague, Père Teilhard de Chardin.

MORE NEW FOSSIL TYPES

The great death-trap of shovel-tusked mastodons was almost exhausted I learned. A dozen jaws and skulls, about thirty tusks, and more skeletal parts had been exposed. They were waiting only for shellac to take them out. Twenty yards from the main deposit, the skull of a peculiar rhinoceros with enlarged nasal bones had been discovered. Doubtless it was a new type.

Already work had been resumed at the quarry just below camp where baby mastodons, deer, foxes and other small mammals had been entombed. The collectors also found in the deposit skulls of a deer with remarkable antlers. They resemble a woman's cupped hand cut off at the wrist and are just about that size. The antler tines are like small fingers.

AN UNBORN BABY MASTODON

The morning after our return Albert Thomson found both femora of an adult female mastodon. She had died lying on her side and in the pelvic cavity were the skull and jaws of an unborn baby. A prize if there ever was one. Thomson performed the accouchement with Granger in attendance as consulting physician. The rest of us watched and offered gratuitous advice. Also we referred to them insultingly as "palæontological midwives" and "fossil obstetricians" who could only deliver a baby still-born!

The unborn baby had a jaw about twelve inches long. In the adult the jaw is nearly six feet in length. The two flat incisor tusks projected only an inch beyond the bone in contrast to the ten-inch plates of a full-grown male.

Except for the pregnant female mastodon, most of the animals that had been trapped in this ancient bog were small. Therefore we conclude that it was

of very soft, sticky mud, but fairly shallow, enabling the larger beasts to extricate themselves.

TRANSPORT OF FOSSILS TO PEKING

In the meantime, Granger and Thomson had been packing the fossils which were ready and I sent them on eleven camels to Hatt-in-Sumu. When we were in Peking, the war news indicated that the northern generals, Yen Hsi-shan and Feng Yu-hsiang, were getting the worst of the struggle. If they collapsed, retreating soldiers and deserters would certainly swarm up the railroad to Kalgan and onto the Mongolian plateau. It might be months before the collections could be brought out if they were not lost entirely. Therefore, I decided to take as many as possible into Peking by car.

McKenzie Young and I started on our second trip to Peking July 22. Père Teilhard had to leave us to return to Paris very much to our regret. Lieutenant Wyman also must report for military duty, and C. C. Young, one of the Chinese assigned to the Expedition by the "Preservation Society," went in to be replaced by W. C. Pei. We drove from Wolf Camp to Changpeh in one day, a distance of two hundred and twelve miles and our record for Mongolia. We remained in Peking while the fossil cases were being repaired and returned to Kalgan on July 31. We had as a guest Lieutenant-Colonel N. E. Margetts, Military Attaché at the American Legation.

A LARGE HERD OF GAZELLES

The grassland gazelles already had begun to herd and just before reaching P'ang Kiang we saw a wonderful spectacle. It was late in the afternoon, and the low sun shot oblique golden paths between the rolling hills. In the shadows of a deep valley we saw a restless mass of yellow forms. Thousands upon thousands of antelope, does, bucks and skipping babies. Colonel Margetts could hardly believe his eyes. Probably nowhere else except in Africa can one find such a concentration of game animals. As the cars swung down the trail, the herd moved slowly up the slope of a low hill. Shafts of sunlight caught the leaders like the spotlights of a theater, changing them to unreal shapes of living gold. They blanketed the hillside and stretched away into the dim mystery of the darkened valley.

FAUNA OF THE PLIOCENE BEDS AT WOLF CAMP

We arrived at camp at eleven-thirty in the morning, having made the trip from Kalgan in a day and a half. The big mastodon quarry had been exhausted and efforts concentrated upon the deposit just below the tents. This had yielded a really good fauna of the region: giraffe, four genera of carnivores, bovids, rodents, rhino, deer, and several skulls of baby shovel-

tusked mastodons, besides a dozen jaws of varying ages. With those obtained from the big quarry south of camp, we had about twenty jaws in all stages of growth from the unborn baby to adult bulls. I suppose that there is in existence no comparable age series of any single species of a fossil animal, except the skulls and skeletons of the dinosaur, *Protoceratops*, which we discovered in 1923.

CHINESE OPPOSITION TO FURTHER WORK

While in Peking I had approached informally the Commission for the Preservation of Ancient Objects in reference to further work in Mongolia. Their attitude was so unsympathetic that it gave little hope that satisfactory arrangements could be made. It was most discouraging.

POSSIBILITY OF FINDING REMAINS OF EARLY MAN

After five years of arduous exploration of the Gobi Desert, we had discovered the region where we might find primates. The bog deposits and river-drift along the shores of this ancient lake may well be the tombs of primitive humans, or near-humans. Such deposits are almost the only ones in which we could have real hope of success. Primates may have been trapped with other mammals in those far dim days when the great shovel-tusked mastodons splashed along the edges of the lake. But careful, systematic excavation of every deposit is the only possible way to succeed. Valuable specimens, each one of which reveals a new page in the book of ancient life, will be found whether or not primates are there. That summer we made a beginning, but only a beginning, and several years of work remain to be done. However, it was useless for us to undertake a systematic exploration of these Pliocene deposits, knowing that it could not be completed.

END OF WORK AT WOLF CAMP

Several untouched localities and possible new formations awaited us only a short distance away in the west, and we must at least dip into them before the season ended. During our absence in Peking Granger had explored the escarpment north and east and found other rich fossil beds. One deposit was exactly like the great quarry south of camp. Two or three huge shovel-jaws were partly exposed. Doubtless the deposit would prove to be as rich as, if not more so, than the other. But we could not afford to spend more time in that formation, although we had but scratched the surface. Two months were gone, and the season was half over. Therefore most reluctantly Granger and I decided to terminate the work at Wolf Camp.

CHAPTER XLIII

GOOD-BYE TO MONGOLIA

CAMP MARGETTS

In 1928, while on a trip of exploration, Granger had seen a rough escarpment fronting a vast basin twenty-five miles southwest of Iren Dabasu. He stopped for an hour and found few fossils but many vipers. The reptiles wriggled out from crevices in the rocks, from behind bushes and from under stones. He came away with a vivid recollection of the place as being most unhealthy. Still, it held possibilities of most important discoveries, and we went there prepared to fight a battle with the vipers for possession. For some strange reason the snakes had virtually disappeared. Only four or five disturbed our peace.

The escarpment was fifty miles from Wolf Camp and almost directly west. Four of the men were left to finish up some work in the baby mastodon quarry, and next day Granger returned with Young to bring them to our new home.

We had pitched the tents some distance back from the escarpment opposite a well two miles away. It was an unsatisfactory location because of the loose sand and I discovered a much better place a mile west of a big road which went north to Iren Dabasu. Five miles south, on the trail, was a well of good water.

After Granger returned with the last of the men, we shifted the tents to the new location. It was named Camp Margetts, in honor of our guest. Our new home was much like Wolf Camp. Behind us was a great plain of gravel and stunted sagebrush; in front, a basin so vast that to the naked eye its northern boundary became only a vague horizon blur of purple. It was like looking over a calm sea from the deck of a giant ship. That night in the silence of the desert twilight, we watched gazelle feeding almost at our feet. A hundred or more picked their way daintily among the clumps of sagebrush, nibbling at the tufts of short stiff grass. Now and then they stood motionless to gaze at the city of cloth which had so suddenly risen on the empty desert. We did not molest these gentle visitors, but shot our meat on the plain behind camp.

FOSSIL-BEARING EXPOSURES NEAR CAMP MARGETTS

It is always fascinating to make the first reconnaissance of a new exposure. Usually some things are easily found. Each man selects a part of the escarpment and skims the cream of the fossils. Later, other specimens not so obvious are discovered. The formation was Eocene, a continuation of the Irdin Manha, but, unlike that exposure, was capped in most places with a few feet of the Houldjin Gravel, Oligocene. In this thin upper layer, *Baluchitherium* bones were found almost at once. Most of them were badly weathered, but a few vertebræ and foot and limb bones were worth taking. Titanotheres occupied the center of the stage for the first days. A new type from the Oligocene, having a saddle-shaped head, was of exceptional interest. It is not allied to *Embolotherium*, the saddle-headed species discovered in 1928 at Urtyn Obo, which is only forty miles away, directly south. The Holy Mesa is just twenty-two miles south. The exposures at Camp Margetts represent the same formations as those of Urtyn Obo and the Holy Mesa. Granger found remains of *Entelodon*, a giant pig-like animal. Its enormous canine teeth would make almost anyone, at first glance, believe that it was a carnivore. Several rhinoceroses were discovered, one of them having a long slender muzzle like a horse. One of the most important finds was a giant carnivore, allied to *Patriofelis*, and not to *Andrewsarchus* of Irdin Manha as might have been expected. Probably it played havoc among the young titanotheres which then roamed the Mongolian plains.

ANIMAL LIFE IN THE BADLANDS

One morning, Colonel Margetts, Granger, Young and I drove to the southwest to follow the course of the escarpment upon the edge of which we were encamped. The great bluff extended for many miles west and south, sometimes almost lost in gentle slopes, only to appear again as a precipitous wall deeply incised by ravines and gullies. Everywhere there were evidences of fossils.

Five miles out in the basin we could see a second exposure of red badlands. Before we reached them, Colonel Margetts shot a wolf and an antelope. Wandering over the brick-red sediments all of us eventually arrived at an isolated cone-shaped butte. From its low summit we looked down upon a relief map of rounded hillocks, tiny flat plains and miniature ravines. Almost every inch was covered with animal footprints. An intricate tracery of innumerable lines crossed and recrossed the smooth red surface. Just below us a herd of gazelle had wandered out from the mouth of a large ravine. Their delicate pointed tracks showed clear and distinct. An antelope had been chased by a wolf around the base of yonder hill. A skull and bleached bones showed where a gazelle had been devoured. Foxes, following hard upon the six-foot leaps

of kangaroo rats, had left their stories. The track of a hare, going slowly, led to the edge of a shallow ravine, but the little creature had left in sudden panic. I wondered why? Close against the bank in soft sand was a wolf bed. No wonder that the hare had run for life. Feathers of a sand-grouse were scattered at one spot, but no tracks showed. The attack had come from above. A falcon, probably, had struck from the air, dropping like a bullet from the clouds.

NIGHTMARE CREATURES OF THE PAST

For an hour I wandered over the badlands, reading the story of life and death in the desert. Sixty million years ago, when these red sediments were being deposited, the drama was the same but with different actors. Then rhinoceroses trod this ground, the gigantic *Andrewsarchus*, greatest of all known flesh-eating land mammals, prowled at night, and fed upon the bodies of dying titanotheres. It was a world of nightmare creatures. The high plateaus of Africa to-day with their open plains and sparse forests offer a convincing parallel to ancient Mongolia.

At one spot in the sediments, I found bone fragments thickly scattered on the surface. Granger marked it for future investigation, and it proved to be a veritable mine. Some natural cataclysm had overwhelmed a whole herd of chalicotheres. They had all died in this spot or had been carried there by water. Skulls and skeletons were packed in a solid bone layer. The chalicothere was a clawed, hoofed mammal, a veritable paradox. The head resembled that of a horse but the hoofs were replaced by enormous claws. Palæontologists have puzzled for years about the meaning of those claws and hardly a reasonable suggestion has been forthcoming. Other chalicotheres are known in America and Europe, but we had found only jaws in previous years.

TRANSPORT OF MORE FOSSILS TO PEKING

On August 13, McKenzie Young and I started back to Kalgan with Colonel Margetts. The war news had become increasingly disquieting with each visit to Peking, and it seemed certain that Yen Hsi-shan would be defeated. To get as much as possible of our collection into Peking while conditions were quiet in the Kalgan region was imperative. We loaded the two cars to capacity and made a quick and uneventful trip to Kalgan. After unpacking the boxes in Peking, we had them repaired as soon as possible, and on August 22 were again on the trail back to Camp Margetts. Rain annoyed us, but in spite of slippery roads we reached P'ang Kiang that evening. On the way to camp next day, I caught two young bustards. They were still in the downy stage, but I had to run hard to overtake them.

STRANGE NEW FOSSIL AMBLYPODS

Events had moved smoothly in camp during my absence. Intensive prospecting had yielded many new and important fossils which had escaped first notice. Chief among them was an extraordinary amblypod, later named *Hypercoryphodon*, from the Oligocene layer, found only thirty yards from the tents. In the spring of 1923, I had discovered a single premolar tooth about fifteen miles east of this camp while we were working at Irdin Manha. It was the first indication of the presence of the order Amblypoda in Asia. In September of the same year, Professor Osborn had found a second premolar under remarkable circumstances which I have already described. But both of these specimens were from the Eocene. It was supposed that the Amblypoda had become extinct toward the close of the Eocene. Finding this new skull indicated that the order had continued to exist in central Asia long after it was extinct in Europe and America. In the Eocene beds, another new and extraordinary amblypod, related to the Uintatheres, was found. This has been named *Gobiatherium*, the "wild beast of the Gobi."

FOSSIL TURTLES

Another interesting discovery was fourteen soft-shelled turtles related to *Trionyx*. Fossil turtles rather bore me as a rule. They show so little. Even back in those incredibly remote days of the Age of Reptiles, turtles were just turtles. They looked about like the turtles of to-day. They do not present any very interesting facts of evolution. But these turtles at Camp Margetts were rather special exhibits. Soft-shell turtles, or others for that matter, that have any parts of the skeleton preserved are extremely rare. These turtles, found by "Buckshot," one of our Chinese collectors, not only had each carapace and plastron, but the skulls, vertebræ, limbs, and feet, almost as beautifully preserved as though the animals had died yesterday. Seven of them lay so close together that they could not be separated and had to be removed in a huge block. The others were taken out one by one. What could have caused so many to die in that single spot? I suppose that they did not all actually die there but were swept by the current into some quiet backwater at the edge of a stream.

SIGNIFICANCE OF A CHARCOAL DEPOSIT

One thing that interested me enormously was a quantity of charcoal close to the turtle deposit. There were many pieces of twigs about the size of my finger. The presence of charcoal probably may be ascribed to fire from lightning. Forest fires to-day often arise from trees being struck by lightning, and doubtless it happened just as frequently in the past. Quite certainly it was in that way that early humans first learned the use of fire.

OTHER EARLY TERTIARY FOSSILS

In addition to the *Hypercoryphodon* skull and the turtles, the men had discovered four Oligocene titanothere skulls, a splendid skull and jaws of a titanothere from the Eocene, and half a dozen good jaws of other titanotheres and rhinoceros, also a complete jaw of *Entelodon* and a palate of *Eudinoceras*.

MORE PROMISING EXPOSURES

The day after my arrival, four of us made a reconnaissance to the south and east to inspect escarpments which we had seen in 1928 from Urtyn Obo. Several promising exposures were found, all being similar to the formation in which we were then working. Obviously there was an enormous area still to be investigated before we could know what was in the region. Granger decided that it would be useless to shift operations while so many fine things were appearing at Camp Margetts, since all the new exposures we had seen were of the same formation.

FINAL RETURN OF THE LEADER TO PEKING

On Saturday, August 30, I started for Peking with McKenzie Young, Liu Hsi-ku, and Pei and seventeen boxes of fossils. I had decided not to return, as there was little that I could do in camp, and Professor Osborn had instructed me to open formal negotiations for another season's work with the Commission for the Preservation of Ancient Objects. Granger took charge of the field operations of the Expedition and expected to remain in Mongolia another month. His stay would depend largely upon the weather. Already it was getting distinctly colder, and the day before we left the temperature at eight o'clock in the morning registered 40 degrees Fahrenheit. During my last trip to Peking, I had learned that Yen Hsi-shan had withdrawn nearly all of the soldiers who had been patrolling the Kalgan-Urga road. Bandits had begun to return to their former hunting-grounds, and it was highly probable that we might have trouble before we reached Kalgan. Fifteen miles south of Hatt-in-Sumu is the Mongol village where all our caravan men lived. Bato's brother ran out to tell us that the previous night thirty brigands had killed two Chinese and robbed their cars only ten miles south on the road. Probably they were still there; he did not know. Young and I went on with our rifles and revolvers ready for action. We were not asking for trouble, but we did not intend to be driven off the road by thirty Chinese bandits! The Chinese cars had been held up near a mud house which had long been a brigand rendezvous. When we arrived, all was quiet and the place seemed deserted. Even the Mongols from several yurts had gone, or kept indoors. We went by at full speed and passed Chap Ser, reaching Kalgan with no difficulty.

YOUNG'S BATTLE WITH BRIGANDS

A week later Young returned. He drove one car and Liu Hsi-ku the other. I had a presentiment that something would happen and asked Young to be particularly careful on the road. Two days of rain had made the trail like grease. He fought mud all the way where we had driven over a hard dry terrain. On the second morning after passing Chap Ser, two Mongol children told him that bandits were robbing a caravan just ahead. It was at the familiar place of the mud house.

The ground was so soft that Young could not leave the road and circle over the hills. He decided to go on. The mud house appeared half obscured by a train of ox carts. Several men stood about. Young had nearly passed the house when from behind a low wall thirty yards away three Chinese opened fire with Luger pistols. Bullets sang all about him, but he was not hit. He slowed down, swung to the right in the seat and took a snap-shot at one fellow who was doing the most persistent shooting. His bullet struck a small stone close to the man's face. Either the steel jacket or fragments of rock gouged the bandit's face and tore off half his ear. He fell backward, but the other two kept on firing.

Young dared not take his hands off the wheel for the car was skidding dangerously. Holding his rifle in one hand like a pistol, he fired two more shots. In the meantime a dozen bandits, standing near horses on the other side of the road, began shooting with rifles and pistols. Some had mounted and were riding after him when Young slowed down, took a good aim, and killed a horse. That ended the matter. The brigands stopped and galloped away.

When the Expedition returned a month later, they learned that there had been eleven bandits in the mud house. They expected an easy time when the two cars approached and got the surprise of their lives. Instead of finding docile Chinese who would have stopped at the first shot, figuratively, they had caught a viper by the tail which proceeded to sting them unmercifully.

BRIGANDS AS "ROAD POLICE"

Young's little battle produced an exceedingly good moral effect. As most of the regular soldiers had gone, the Merchants' Association of Kalgan supported the road police. They sent up reinforcements and for a few weeks the trail again became comparatively safe.

Virtually all the road police were former bandits who for reasons of their own preferred to be honest citizens for a short time. The "general" of the police was a brigand chief. It was rather a comic situation, because at any moment some particularly rich caravan might be too great a temptation, and the entire force would again take to the life of robbery and murder.

CLOSE OF THE 1930 FIELD SEASON

Young and Liu reached Camp Margetts at nine o'clock on the evening after the attack. More amblypods had been discovered and the men obtained some of the most valuable specimens of the entire Expedition in the last two weeks. It was not until the end of September that they broke camp. The camels were sent to Hatt-in-Sumu with the specimens. The men went by motor. Winter came in a rush as it usually does in Mongolia. A blizzard raged all the afternoon and night of October 2. The camp was drifted high with snow. Granger knew that it was time to be gone. Lucky it was that the Expedition moved out when it did, for things began to happen on the road the day after their departure. Bandits had captured five Chinese merchants and held them for fifty thousand dollars ransom. In retaliation the soldiers took the father and brother of the chief brigand. This started a real warfare, for isolated groups of bandits consolidated into a force of four or five hundred. The road police hastily retired from Chap Ser, leaving the robbers in possession. Our cars were the last to pass on the trail for several months.

Young remained at Changpeh to receive the camels which were bringing our fossils. After a long delay they arrived. By making a long detour, they had avoided the bandits clustered along the road.

SIGNIFICANCE OF THE FOSSIL COLLECTIONS

The fossils spread out upon the laboratory floor were an impressive sight. It was the largest and one of the most important collections ever taken out of central Asia. The dinosaur eggs and some other specimens discovered in previous years were more spectacular and had more popular interest, but from the standpoint of pure science they hardly surpassed this collection. It gave us additional proof that the central Asian plateau was one of the greatest centers of origin and distribution of animal life during the Age of Reptiles and the Age of Mammals. It showed that Mongolia was even more favorable for the development of many types of mammals than was Europe or America, and continued to be so, long after these groups had disappeared in other parts of the world. It gave much additional knowledge of the climate, vegetation, and physical conditions of this great incubator of world life.

THE UNFINISHED TASK

True, we have not been successful in one objective of our search—the "dawn man." It is a scientific tragedy that Chinese opposition to foreign investigation should end our work just when that goal might be attained. Still, we have shown the way, have broken trail as it were. Later, others will reap a rich harvest. We are more than ever convinced that central Asia was a palæontological Garden of Eden.

PART II

EXPLORATIONS IN CHINA

CHAPTER XLIV

THE HUNT FOR TAKIN IN SOUTHERN SHENSI

By Roy Chapman Andrews

OUR QUEST BEGINS

On September 8, 1921, accompanied by Captain W. F. Collins, I left Peking in quest of the takin, *Budorcas bedfordi*, that rare bovid of the "golden fleece," which inhabits the Tsinling Mountains of southern Shensi. Takin of different species are also found in Assam and in western China, but the Shensi form has been hunted less than any of the others and has been killed by not more than seven or eight foreign sportsmen.

FROM PEKING TO KWANYINGTANG BY RAIL

From Peking we proceeded southward on the main Peking-Hankow railway to Chengchow. There we took the train going westward through Honanfu to Kwanyingtang which at that time was the terminus of the incompleted railroad to Sianfu. At Kwanyingtang our travel by rail ceased, and there lay between us and the peak of the Great White Mountain many miles of dusty road. This road is so ancient that in places the passage of countless carts and animals since the dawn of Chinese history has cut a canyon with sheer brown walls of loess rising two hundred feet above the track.

TRAVEL BY MULE LITTER

At Kwanyingtang our difficulties began. When we started to make arrangements for our pack, we found that the recent military operations had almost paralyzed caravan transport. All the mules within a radius of forty miles had been commandeered by the soldiers, who were holding them for possible emergencies. We asked the commander of the troops for mules. He very kindly promised them for the next day, but it was only by making ourselves a nuisance to his subordinates at the yamen that we succeeded in obtaining them after three days' delay. We had four pack-animals and two mule-litters, or "chair-nests," as the Chinese call them. The framework consists

of two long poles tied at the ends to saddles, which are placed on the backs of two mules. Between the animals is constructed a rope basket, in which the traveler piles his bedding. A circular piece of matting protects him from the sun. The whole arrangement looks somewhat like a small American prairie-schooner.

ON THE ROAD TO SIANFU

During the first day's march our trail paralleled the railway which was being built to Sianfu. The construction work had already reached Shanchow, one hundred *li*—about thirty-three miles—from Kwanyingtang. This road, when completed, will open up a direct route from Sianfu to the far western province of Kansu, and will traverse a wonderfully rich country, known for its wheat, and for its cotton, which are grown from American seed and are the finest in all China. We saw hundreds of acres pink with buckwheat flowers; orchards of persimmons, pears, nuts; fields of vegetables, corn, *kaoliang*, rice and millet. Yet in spite of the trade, which makes heavy traffic, no work is done on the roads. What was good enough a thousand years ago is good enough to-day, and I have never seen such a road as we traversed on that first march. In the winter, its ruts are filled deep with yellow dust; in the summer it is flooded by heavy rains, that could carry away carts, mules and men. At that time, after a two days' rain, the road was filled with liquid mud through which the carts, mired up to the axles, were dragged. In the worst places there was a jam of mired carts and floundering mules. Although the Chinese carter usually lets his fellow carters shift for themselves, on this road he has to be civil; often he cannot pass until he has helped pull obstructing carts out of the mud.

TRAFFIC ON A CHINESE ROAD

Nowhere in China have I seen so much traffic on a road in the interior: two-mule and three-mule carts, carrier-coolies, mule-litters, ox-trains, camel caravans, sedan-chairs and, most of all, wheelbarrows. These wheelbarrows, with four- or five-hundred-pound loads, are wheeled for hundreds of miles over roads difficult to travel even on horseback. There are usually two men to a barrow. The one at the handles, by means of a strap over his shoulders, takes much of the weight from his arms, leaving his hands more or less free to guide and balance the load; the other in front drags it forward with a ten-foot rope. Panting and straining, the men pull their load through foot-deep yellow dust, lifting it over rocks and dragging it up hills; at night they gulp a bowl of soup or macaroni and fall asleep on the ground in the inn courtyard among the pigs, chickens and mules.

Though I usually camped in temples while traveling on the main highways

of interior China, we did not always find it practicable to do so in Shensi. During the great rebellion of 1862, the Mohammedans swept in a destroying horde from the west, burning and wrecking many of the temples in their path. Some temples escaped complete destruction, and a few new ones have been built, but they are often some distance from the villages and the muleteers prefer the inns. A Shensi inn is a most uninviting place from a foreigner's point of view, with stuffy little rooms, which are not any too clean. We usually preferred camping in the open courtyard.

TUNGKWAN

At Tungkwan we passed through one of the most important and strongly fortified cities in central China. Here at the great bend of the Hoang Ho, three provinces intersect, and there is a junction of the main trade-routes through Honan, Shensi and Shansi. Tungkwan is a picturesque city situated on the summit of a pass that drops sharply away to the broad reaches of the Hoang Ho River. The only approach from the east is by means of the main road. It winds up a steep incline, and twice it is barred by heavy gates before the city walls are reached. Few places in China would be so easy to defend or so formidable to invade.

Most of the difficulties of the new railroad lie east of Tungkwan. Once the pass is crossed, the engineers will have little to contend with, for the country is a great plain between the Tsinling Mountains on the south and the Wei River on the north.

A SIDE TRIP TO HUA SHAN—THE FLOWER MOUNTAIN VILLAGE

Not far beyond Tungkwan, but off the main road, lies Hua Shan, "Flower Mountain," one of the five sacred peaks in China. We made a short march to the Flower Mountain village, since it was the eighth day of the eighth moon, which is a time of celebration for the Chinese, and we were as anxious as our boys to see a spot with so beautiful a name. But the village proved to be one of the least attractive on the road to Sianfu.

The redeeming feature of the village is a temple that rivals the most splendid in Peking. An old priest led us about the courts and through the dust-filled halls. He showed us a rock upon which were some ideographs purported to have been cut by a Tang Emperor. To a bowed and twisted tree the sage Mencius had tied his horse three hundred years before the Christian era, and in the great marble pool so many wonderful things had happened that even the most hardened tourist must have been impressed. He was a dear old soul, that priest, and so evidently loved his temple that we forgave his lies. I think no one could have lived in that beautiful shrine without believing that the finest things in Chinese history had somehow had their origin there.

In the autumn and winter the wheat-fields beyond Hua Shan are alive with geese, but in September Captain Collins and I found little game except snipe, hares and pigeons. We always began our walk about sunrise, and while splashing through a stretch of marsh or muddy cornfield, usually managed to shoot enough birds for our daily needs.

THE ANCIENT CAPITAL, SIANFU

As we neared Sianfu on the seventh day, thousands upon thousands of loaded barrows formed a continuous creaking line, and half a dozen times we had to wait our turn with a score of carts or a caravan of camels at some narrow place or difficult crossing. The ancient watch-towers, whose signal-fires once guarded the highway against approaching danger, stood beside the road. The far skyline was broken by enormous conical mounds—the graves of former emperors. All about us were signs of former grandeur befitting the ancient capital of the Empire, dating back to the Tang dynasty, one thousand to thirteen hundred years ago. The walls and the massive gates, built before the discovery of America, are excellently preserved and rivaled only by those of Peking. We passed down the main street from the eastern gate to the drum and bell towers. In this quarter of the city lived the ill-fated Manchus who ruled the country prior to the revolution of 1911, when ten thousand were killed and this eastern city left a mass of smoking ruins.

Sianfu has so much of historical interest that in our short stay we could do no more than skim the surface. The splendid palaces and yamens, archways and temples fill one with delight, and the monuments and tablets, some of which date back to the late Han dynasty (B. C. 206–A. D. 220), are priceless possessions worthy of the greatest care. But, alas, they stand in open pavilions or damp halls, their surfaces black from the ink of rubbings, which venders sell for twenty or thirty coppers in the temple courtyards.

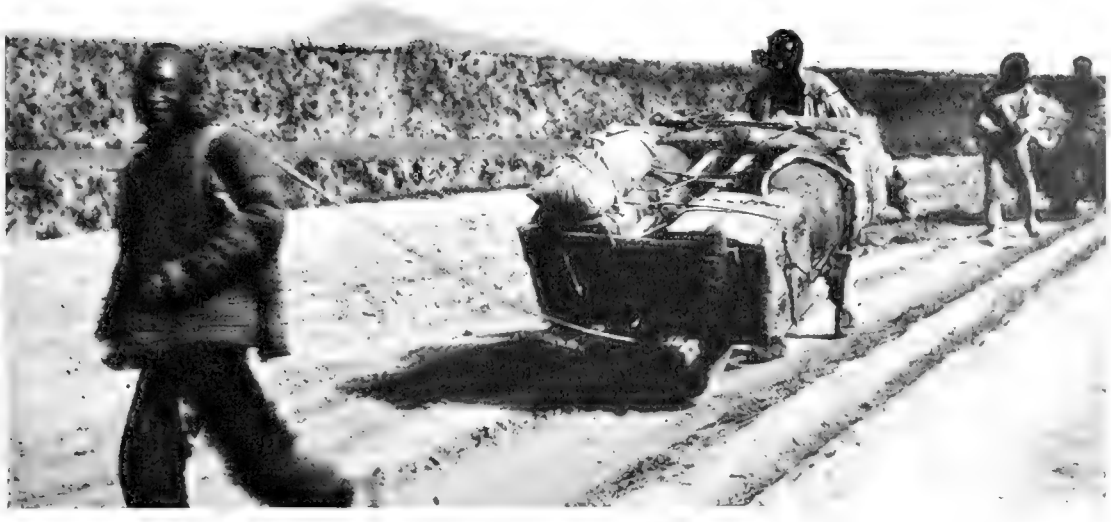
We saw the famous Nestorian stone, the oldest record of the Christian Church in China. It describes in Syriac and Chinese characters the fortunes of the Church from the earliest mission, 635 A. D., giving the names of its bishops and indicating the protection it received from various emperors. The tablet was discovered under an old wall in Sianfu by a Jesuit priest in 1625, and a temple was built to cover it. In 1862, the Mohammedans destroyed the temple but spared the tablet because of the cross at the top and the Syriac characters on its sides. It stands now in a small hall of the Confucian temple.

MILITARY DISTURBANCES

We spent only two days in Sianfu on the way to the Taipai Shan, or "Great White Mountain," for there was some doubt as to our being able to leave the city. Only five miles beyond the western gate of Sianfu, the new

PLATE CV.

A. OUR MULE LITTERS APPROACHING THE WALLED CITY OF TUNGKWAN.



B. WHEELBARROWS ON THE ROAD TO SIANFU.

The man at the handles, by means of a strap over his shoulders, takes much of the weight from his arms, leaving his hands free to guide the load; the man in front drags it forward with a rope

A. [illegible] IN SHENSI HIGHLANDS

[illegible] litters, ox-trains, camel caravans, sedan-chairs and wheelbarrows travel [illegible]

B. GATES OF THE ANCIENT CAPITAL OF SIANFU.

Tuchun (Feng Yu-hsiang) was carrying on a military operation of considerable proportion against the troops of General Chang Fei-sheng, and wounded men and cartloads of rifles and equipment were continually arriving in the city. Unfortunately, the action was taking place directly on the road that we wished to travel. It was certain that General Chang's men would soon be defeated and probable that they would flee to the hills and become brigands. But Captain Collins and I felt confident that we could take care of ourselves, and decided that if we could get out of the city gates without being stopped, we would follow a road north of the river, which would avoid the region of immediate trouble. We had less difficulty than we had expected, for the northern road is the direct route to Kansu, and the guards inferred that we were going there. For five days we traveled westward and southward, skipping from road to road to avoid the larger cities where we were most likely to run into trouble.

LINGTAI MIAO—HUNTERS' HEADQUARTERS

At last we arrived at the base of the Tsinling Mountains and started up a rocky river valley. The rainy night had enveloped us long before we came to the little mountain village of Lingtai Miao, which has been the headquarters of every foreigner who has killed the Shensi takin. We camped in a tiny temple, sleeping at the feet of a half-dozen grinning gods, who disturbed us not at all. We had reached our goal—the green slopes of Taipai Shan, the "Great White Mountain."

The village of Lingtai Miao was only a straggling main street bordered by mud huts in which human beings, mangy dogs, pigs, chickens and goats lived side by side. Until I saw the people themselves, I wondered how so wretched a place could exist amid such beautiful surroundings. Ordinary Shensi farmers are unprepossessing, and many of them show the ravages of opium, but these mountain folk were even lower in the human scale.

CAMPING IN A TEMPLE AT THE FOOTHILLS OF THE TAIPAI SHAN

The temple where we were camped lay in the midst of rice-fields in a valley beside a mountain stream bordered by straight white poplars. A few hundred yards away the foothills of the Tsinling range rose steeply, range upon range, into the gray cloud-veil hanging about the summits of the Taipai Shan. We did not have the temple to ourselves, for a dozen village soldiers had taken up their quarters in the rooms on each side of the court. We spread our belongings at the foot of the altar in the main building. A blear-eyed old priest had made himself a bed of straw in one corner of the room. His duties seemed to consist solely of keeping alight the tiny oil-wicks that burned at the feet of the gods and changing the bowls of food upon the altar. But he wore an expression

of utter exhaustion and always retired at dark to sleep uninterruptedly until broad daylight.

The morning following our arrival began with floods of rain. It was two days before the rain ceased and we could start for the summit of the mountain, the home of the takin.

ENGAGING A HUNTER

We engaged as guide a native by the name of Yong, the son of a famous hunter who had formerly assisted all the other foreigners in killing takin, but who died two years ago. The son, we subsequently learned, was one of the worst scoundrels, but since he was the only hunter in the neighborhood, we could not have dispensed with him.

WE SET OUT FOR THE HUNT

On a beautiful morning we left the temple, with eight bearers, carrying our food, collecting outfit and sleeping-bags. The way led up the main valley, and the rocky river-bed gave us splendid pheasant-shooting. The birds were continually sailing down from the foothills for their midday drink. They were strong on the wing and seemed to be plentiful. Had we really hunted them, we could probably have shot more than a hundred in a few hours. We killed nineteen pheasants, one hare and one woodcock without going more than a hundred yards from the trail.

When we turned abruptly to the east and entered a side valley, which rapidly narrowed into a canyon, climbing began in earnest. The lower slopes of the mountain are thickly blanketed with a dense forest of birch, oak, poplar, spruce and larch; at about six thousand feet, the dwarf bamboo begins; above this is the rhododendron belt, extending to timber-line at about eleven thousand feet. Between the narrow walls of the gorge above us, we could see a ragged skyline of green-clad peaks; beneath our feet was a chaotic mass of stones and boulders on the banks of a mountain torrent. The trail so frequently crossed and recrossed the stream that we were in the water a great part of the time, and after a half mile or so we gave up all attempts to keep dry. It was dark when we climbed out of the trail to a huge rock wall, which rose sheer above us a hundred feet, leaving a narrow basal ledge. The men cut bamboos for beds, and we grouped ourselves about the fire, trying to dry portions of our sodden garments. We were on a level with the lower peaks. Above us we could see snow-capped ridges in the starlight. It was very still up there. Not even the roar of the stream reached our ledge; not a bird-note sounded in the night. In our fur sleeping-bags, Collins and I lay propped against the rock face, smoking. We felt at peace with all the world and slept with the sweet odor of the larch trees in our nostrils.

A MOUNTAIN MEADOW CAMP

A two-hour climb in the morning, up a slope so steep that we were well-nigh forced to go on all fours, brought us to a meadow, thick-carpeted with long brown grass. There, in a spot that appeared to have been a wood-cutter's camp in former years, we pitched our tents and covered a skeleton of poles with grass and dwarf bamboo for the three men who were to remain as hunters.

Behind us the meadow met a rhododendron jungle, its brown grass giving place to dark green leaves, which spread up the steep slope of a ridge, over the summit and away into the peaks and chasms of far-off mountains. Although it looked harmless enough, we learned to dread the tangle of its thickly twisted branches. To the east a canyon cut us off from the distant snow-capped summits; to the west lay a tumbled mass of lichen-covered granite boulders that as an avalanche had fallen away from the cliffs above. It was a wild place and a fit home for one of the strangest beasts of this strange land.

LIU PREDICTS SUCCESS

For two days we hunted without success in the region of the camp; takin had been there years before but there were no fresh signs. While at breakfast on the third morning, we noticed one of the hunters, an old man by the name of Liu, busily engaged beside a rock a few yards from the tent. He made himself a little shrine of grass and leaves and then produced a half-dozen sticks of incense. These he lighted, and with mumbled prayers and incantations kowtowed before his joss. We watched the performance with some amusement, but the hunters took it very seriously. At the end, the old man announced that we would certainly find takin that day.

CLIMBING TO THE PEAKS OF THE TAIPAI SHAN

An hour later our hunters started eastward toward the snow peaks, skirting the upper end of the gorge near camp and cutting directly through the rhododendron jungle. Sinking into holes, bruising ourselves on hidden rocks, twisting, turning and crawling through the maze of ropelike branches, we followed them on what seemed to be a hopeless chase. At noon we emerged on a granite buttress projecting into the canyon and dropped exhausted on the sun-warmed stones.

TAKIN AT LAST

Almost as soon as we were settled, Yong whispered, "*Yeh, niu*"—"Wild cow,"—and pointed to a bamboo-covered ridge seven or eight hundred yards away. I nearly slipped off the ledge when I caught a glimpse of a yellow speck with another near-by. The glasses showed them plainly—huge, golden-yellow

brutes, moving easily amid the bamboo jungle on a slope so steep that they seemed to be hanging by their horns.

The takin do resemble a cow superficially a good deal more than they do their nearest relatives, the chamois, Rocky Mountain goat, serow and goral. These animals form a strange subfamily, the goat-antelopes, so-called because they hold an intermediate position between true goats and true antelopes. This is an excellent example of a group that, with its origin in Asia, has sent one branch, the chamois, to Europe, and another, the mountain goat, to America.

The takin that I had imagined were never stranger than the animals I saw on that sunlit peak of the Taipai Shan. Everything about them seemed unreal—the great Roman nose, the cow-like horns and the clumsy body glistening in the sun like molten gold against a background of dull green leaves. Unlike the white rhinoceros, which is not white, and the blue fox, which is not blue, the takin of the "golden fleece" is really golden in color. From the end of their enormous noses to the tips of their abbreviated tails, these Shensi animals are a golden yellow without a patch of darker shading.

STALKING THE GAME IN THE BAMBOO JUNGLES

We watched them for half an hour, hoping they would settle themselves for their midday rest. But they continued to browse upon the bamboo leaves, always moving slowly upward. The hunters told us that we could not reach them and return to camp before night. We scoffed at that, but for safety's sake sent two men back to the tents to bring our sleeping-bags and some food. Then we began to stalk.

It was necessary to circle about the upper end of the canyon into which the granite ridge projected, descend to the stream-bed and climb the peak where the animals were feeding. We scrambled up and down slopes that were almost perpendicular and fought our way through a bamboo jungle that was even worse than the rhododendrons. The dwarf bamboo stalks are not larger than one's finger and only ten or fifteen feet high, but they grow so close together that it is impossible to get through except by main force, or to see for more than ten feet ahead. The whip-like stems slashed us until our hands and faces were bleeding. To add to the discomfort, a drizzling rain began, and in half an hour we were soaked to the skin and shivering in spite of our strenuous work. Somehow we got to the bottom of the gorge, made our way down the stream-bed, half the time knee-deep in icy water, and started the long climb up the thousand-foot peak where the animals had been feeding. When we reached their tracks, there were no takin and we were nearly exhausted. Yong said they had gone higher still. But when we reached the summit just at dusk, we found that the tracks led far back into the mountains.

PLATE CVII.

A. CAMP IN A MEADOW ON THE TAIPAI SHAN.
Tents and skeletons of poles covered with grass and dwarf bamboo gave us shelter.

B. CHINESE HUNTER WITH AN ADULT FEMALE TAKIN.

A. A BAMBOO JUNGLE.

The dwarf bamboo stalks are not larger than one's finger, and only ten to fifteen feet high, but they grow so close together that it is impossible to get through without force, or to see more than ten feet ahead.

B. A CLIFF OF THE TAIPAI SHAN.

A WET NIGHT IN THE GORGES

There was nothing for us to do but descend and make the best of a wet night. We could look across the canyon to our brown tents in the little meadow less than a mile away but as inaccessible as the stars. It had taken us nearly six hours of killing work to reach this peak, where we had seen the takin from a point not more than eight hundred yards away. When we got to the bottom of the gorge, it was black night and raining steadily. Fortunately the matches in my waterproof case were dry, and we managed to start a feeble fire.

We felt pretty low, not so much at the prospect of a cold, wet night, but because we had nothing to eat for to-morrow. We were both faint from lack of food and we could hardly face another day of grueling work without nourishment. We had little hope that the men who had been sent back would find us; it seemed absurd to think that any human being could travel in the dark where it had been well-nigh impossible to go in the daylight. Yet about ten o'clock we heard a rustling in the jungle, and a few minutes later the two men appeared. They had seen our fire and made their way down that treacherous stream-bed for more than a mile in thick blackness with only the tiny point of light to guide them.

MY FIRST TAKIN

The sun was high the next morning before we reached the summit of the peak and picked up the takin tracks where we had left them the night before. They led up and back towards an amphitheater of higher ridges, but the trail was fresh and plain. At eleven o'clock we struggled through a particularly bad patch of jungle and sank down to rest upon the rocks in the sunlight. After a short rest, our men climbed out on a granite pinnacle for a look about. Almost immediately they returned, trembling with excitement. The takin were there—we could shoot them from the granite pinnacle. It was a dangerous bit of work to reach the spot where the men had been. When we peered over the edge of the rock, I saw nothing but the bamboo jungle, shimmering in the sunlight. Then there was a slight movement far below, and an animal emerged from the cover to stand quietly, gazing directly at us. I could see that it was small, but no others were in sight and Yong urged me to shoot.

Holding well below the belly-line, I fired. The beast plunged forward. At the first shot six other takin, which had been asleep, leaped to their feet and dashed madly about, scattering up and down through the bamboo thicket. Now and then we could catch a glimpse of a yellow form as it passed through an open space. It was down-hill shooting at long range under the worst conditions possible.

In less than a minute it was all over, and Yong and I descended to find our

kill, while Collins watched far above. We found my first animal, a nursing calf, with a broken back. A little below, Yong put up a full-grown beast, which we thought had been wounded, and I snapped at it uselessly as it dashed down hill. A moment later a cow leaped out twenty feet ahead of me. I fired quickly, breaking a hind leg, but she kept on going without a pause. Finally she stopped beside a tree, and I shot through the bamboo-tops, dropping her dead in her tracks. Although we searched the jungle carefully, we found no other signs of wounded animals and we came to the conclusion that the two I had killed were our only bag.

Before starting back to camp, we photographed and skinned the takin. My camera was wet and the pictures were not good. At two o'clock in the afternoon we set out for camp. With the load of skins and sleeping-bags we could not go by the way we had come, and even though the tents were less than a mile away in a straight line, it was two days before we reached them.

COLLECTING BACKGROUND MATERIAL FOR MUSEUM GROUP

Collins and I spent the next day selecting a spot with the proper background for the takin group, making photographs and collecting the grass, leaves, rocks and other accessory material. We decided upon the side of a steep, bamboo-clothed cliff, leading up to a rocky ledge, on which the animals like to sleep and sun themselves. The background was to be the peak where we had killed our specimens. We took enough bamboo for the entire group, first brushing the stalks with weak formalin and glycerine and then wrapping the bundle with burlap. We selected various samples of rock with dried lichens attached and photographed the characteristic fissures and formation. In a solution of water, formalin and glycerine, we preserved fresh sprigs of bamboo and grass, from which plaster casts were made at the Museum and wax leaves prepared.

My Chinese taxidermist, who had been trapping industriously while we were absent, presented me on our return with a trayful of rare mammal specimens. Two I recognized as known only from a single specimen each, and three others were undoubtedly new to science. The mountain was most surprising in its variety of small mammalian fauna. Instead of one species far outnumbering all the others, as is the case in most localities, there was a great variety of species with no one predominating. The fauna of this region is important and very little known.

HUNTING NEAR SNOW-LINE

Another day of hunting in the vicinity of camp demonstrated that it was useless to look for takin there. Collins and I decided to take three bearers

with food and sleeping-bags and strike into the mountains near the spot where we had killed the "wild cow." The taxidermist was to continue work at the camp in the meadow until we sent him bearers from the village.

Half-way down the mountain we left part of our things in a large cave, and with three light loads set off toward the snow-clad peaks where we were confident the hunt would end. It began to rain in the afternoon and we camped early under an overhanging rock. The weather of the Taipai Shan was a constant source of surprise. The sun always rose in a cloudless sky, but at any moment gray mist, accompanied by a drizzling rain, might steal in from above or below. Not a day passed without rain. It might be only enough to wet the bamboos, but that insured a thorough soaking for us as we pushed through the thick bushes.

Our second hunt was a disappointment. We found fresh tracks and followed them for days at a time, hunting every inch of the forested peaks, but did not get a shot at an animal. Once two takin were within fifty yards of us, but they stole away noiselessly through bamboo so thick that we could scarcely move. How a beast nearly as large as a cow (for a full-grown takin weighs 650 pounds) could move quietly in that tangle was a mystery. At night we were so tired that we could hardly cook our food. After supper, we crawled into our fur bags and went wearily to sleep under ledges or overhanging rocks. But in the morning we were always fit and ready for the day's work. At last we woke to a world white with new-fallen snow, and we knew that the hunt was ended. It would be useless, as well as dangerous, to climb those peaks while the snow remained, so we retraced our steps down the mountain toward the village.

WE LEAVE OUR HUNTERS TO COMPLETE THE WORK

While it was somewhat discouraging not to be able ourselves to finish the work we had begun, I decided to leave my two men with instructions not to return until they had at least two more takin. We felt sure that they would have success, though it might be weeks before the snow melted sufficiently to make hunting possible. I had all the necessary data for the group and I was not needed, for the men were well trained and could be depended upon to follow instructions to the letter.

We spent three days packing specimens, of which we had several hundred, and preparing our men for their new hunt. Then we were ready to go, but transportation facilities presented a problem. The villagers of Lingtai Miao looked on us as heaven-sent providers of a year's income and asked such absurd prices for their mules that we vowed we would walk to Sianfu with our specimens upon our backs before we would agree to their ridiculous demands.

OUR CONTRACT WITH RETREATING SOLDIERS

While I was busily packing specimens the afternoon before arrangements were completed for our departure, there was great excitement at the temple. It was reported that two hundred brigands were on their way up the valley and would soon arrive. I was decidedly skeptical about the report, for I could not see why two hundred, or one quarter of that number, would come into so secluded a valley unless they were fleeing from pursuing soldiers. That was exactly the case, and just at dark the village was filled with bands of men. They were hard-looking fellows and heavily armed. Forty or fifty crowded into the temple and manifested the liveliest interest in our belongings. We took particular care to treat them cordially and show that our boxes contained only skins of birds and animals. We had no fear that they would covert our rifles, for they already had more than they could carry.

Not long after their arrival, the captain, or chief, called upon us. He was very civil and we told him that we were from Peking and what we had been doing. He informed us that his men were part of the forces of General Chang Fei-sheng, who had been fighting just outside Sianfu when we arrived there a month before. This section of his forces had originally numbered a thousand men, but only two hundred now remained. The captain had a slight wound in his right hand and asked if I would dress it for him. Naturally I was glad to do so and he seemed pleased. He said that many of his men had been wounded and inquired if I would be good enough to help them the next day. I promised to begin hospital hours at nine o'clock in the morning, and he left after telling us that he would do all in his power to see us safely out of the valley.

When he had gone, Collins and I held a conference. Although the men did not yet consider themselves brigands, that is actually what they were. It was evident that the captain had little control over the force, which was gradually disintegrating and drifting away into the hills. The men were hunted outlaws who would be killed if they returned to their own homes, and they had no recourse except to live on the country and the people in it. Since they did not need rifles and knew that our boxes were filled with useless specimens, it seemed improbable that they would rob us unless one of them chanced to want some special article in our equipment. We were afraid, however, that they would hold us as hostages. Taking hostages was rather common in China, if an outlaw wished to receive a pardon or obtain an officer's commission in the Chinese army. Collins and I realized that we were absolutely in the power of the brigands and that our only hope lay in making them grateful to us for "services rendered."

WE KEEP HOSPITAL HOURS

Next morning the hospital opened at the time scheduled. A chronicle of the wounds I dressed that day would not make pleasant reading. Suffice it to

say that I learned how much of his anatomy a Chinese can lose and still carry on. All the men appeared grateful for the help I gave them. While I was looking after them, Collins slipped away with the two hunters and guarded them until they safely reached the hills. As we sat at dinner that night, we congratulated ourselves upon handling a delicate situation with skill. The day had passed very well, and the captain had promised that we might leave the next morning.

OUR RETURN TO PEKING

It was noon before our mules arrived and we finally got under way. The captain gave us a guard of five brigands to see us safely beyond the pass, which was held by his forces, and we left the temple amid the friendly farewells of a hundred men. By night we were safely out of the valley and well upon the main road to Sianfu. We encountered a body of regular soldiers, if that name can be applied to any troops in China, at the inn where we slept. They knew perfectly well that the men they had been sent to hunt were only a few miles away, but they were content to let well enough alone and not risk any further trouble.

Although we found the brigands to be such amiable fellows, reports from my two hunters showed that we had left just in time. A few days later, the men evidently got entirely out of hand, and if we had still been within reach, they would probably not have let us get away with more than the clothes on our backs.

After a rather peaceful five days' journey we reached Sianfu. Along the way, we found an abundance of game; geese had arrived in thousands, every marsh was alive with snipe, and the shooting could be varied with bustards, quail, hares, ducks and pheasants. We were in a sportsman's paradise where we could kill all the birds we wanted near the main road. We spent only three days in Sianfu because we had so much to do in Peking.

Some weeks after our arrival in Peking, our hunters returned from the Tai-pai Shan with a glorious bag including three takin. Although it had been disappointing not to be able to finish the work we had begun ourselves, it was gratifying to know that our Museum group would be complete, and that our season in Shensi had been a success.

CHAPTER XLV

COLLECTING IN NORTHERN AND CENTRAL CHINA

By Clifford H. Pope

MY FIRST COLLECTING TRIP IN CHINA

In the summer of 1921, Dr. R. C. Andrews initiated me into the art of collecting reptiles and amphibians in China. Within a month I was to experience and learn enough to make me feel capable of setting out on my own account to collect in regions new to me.

On our first trip we set out from Peking for the Tung Ling or Eastern Tombs region in Chihli Province. After a four days' journey we reached our first camp site in the old imperial forest preserve of Tung Ling. Although the mountains a few miles below us were devastated, only the preliminary work of deforestation had reached the vicinity of our camp and we were able to secure forest forms which were virtually extinct elsewhere in northeastern China. The heavy rains in this area made Doctor Andrews' mammal hunting almost impossible and trapping rodents and other small forms exceedingly difficult. Fortunately, I was able to secure data on the life-history of a rare skink, *Eumeces pekinensis*,[1] which was described by Leonhard Stejneger[2] as new in 1924. It was found nesting in colonies on open hillsides near our camp. Each lot of eggs was discovered under a stone where it was carefully guarded by a female.

Because of the incessant rains which interfered with our work, we decided after a few days to move down to Hsinglungshan, a logging center through which we had passed on the way up to the mountains. Here, in a broad valley, fine crops flourished and a lively lumber trade was in progress. The local population soon turned out in numbers to collect for us and our camp swarmed with activity. After a few days of successful collecting, we moved again down

[1] Schmidt, Karl Patterson. 1927. "Notes on Chinese Reptiles," *Bull. Amer. Mus. Nat. Hist.*, LIV, Art. IV, pp. 502–503; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 76, pp. 467–551, 1930.

[2] Stejneger, Leonhard. 1924. "Herpetological Novelties from China," *Occ. Papers, Boston Soc. Nat. Hist.*, V, pp. 119–121.

the valley and camped by a pond in the mountains some twenty-six miles below Hsinglungshan.

REPTILES AND AMPHIBIANS OF THE TUNG LING REGION

At the last two camp sites we secured nearly five hundred reptiles and amphibians, as well as a great many fish. The commonest frog of the region proved to be the ubiquitous T'ien Chi of the Chinese, *Rana nigromaculata*. Tadpoles of this form were also collected. Next in abundance came the grass frog, *Rana amurensis*, while the third species of frog collected was the common toad of northeastern Asia, *Bufo bufo asiaticus*. All of these amphibians are well-known species, but, oddly enough, they are the very ones whose subspecific or even specific positions are not understood, and the series procured have been of great value in studying the problems of relationship and distribution.

The reptiles collected represented some eleven species—four lizards, six snakes and one turtle. One of the lizards, a skink, was described by Mr. Karl P. Schmidt,[1] 1927, as a new species, *Leiolopisma septentrionale*. The spotted lacertid, *Eremias argus*, was so abundant that a few hours' work by the Hsinglungshan boys gave us a sufficiently large series, and one example even came into camp of its own accord. More specimens of the pit-viper, *Agkistrodon halys*, were secured than of any other snake, but the series of *Elaphe schrenckii* was of greater interest, this form seldom having been taken in Chihli Province or any other part of China south of Mongolia and Manchuria. It is a northern form, common in Manchuria and the region lying between that country and the sea. An example of *Dinodon rufozonatum* was found devouring a pit-viper and brought into camp. Their discoverer had cleverly tied the two together so firmly that the aggressor was unable to disgorge its prey. *Dinodon rufozonatum* is a remarkably omnivorous feeder, eating frogs, toads, fish, lizards and birds, as well as other snakes. The other snakes collected represent three widely distributed species, *Elaphe dione*, *Coluber spinalis* and *Natrix tigrina lateralis*.

COLLECTING AT KICHOWPEH

From Hsinglungshan we went down and out of the mountains to Kichowpeh, just at the foot of the range, where we put up at an inn. It soon became evident that we had arrived in time to collect a large series of the brevicipitid toad, *Kaloula borealis*, while it was breeding in the quiet water of ditches within the walls of the town. After a few days' work about Kichowpeh, we concluded our collecting in the Tung Ling region and returned to Peking.

[1] Schmidt, Karl Patterson. 1927. "Notes on Chinese Reptiles," *Bull. Amer. Mus. Nat. Hist.*, LIV, Art. IV, pp. 498–499; *Preliminary Reports*, Central Asiatic Expeditions, Amer. Mus. Nat. Hist., II, No. 76, pp. 467–551, 1930.

THE "ART" OF COLLECTING IN CHINA

While this trip had afforded only a few days of actual collecting, because of the heavy rains and the time spent in travel, it had taught me something of the art of collecting in China. I say art, because, in this land of ancient culture, where human relations figure so largely, the ordinary methods do not suffice and experience alone can teach one how to obtain the best results. Within a month I had gained some insight into oriental psychology and methods of working with the people which was to prove extremely helpful in my future work in other regions. Satisfactory relations with the native farmers must be established, especially when we ask them to do much of the actual catching of live specimens. In approaching a farmer for information, one cannot make abrupt, specific inquiries, because the oriental farmer is in some ways a polished gentleman, and his mind must be tactfully directed toward the desired subject. It is important also to have some experience in eastern bargaining. In petty trading the rural oriental almost invariably asks a price far beyond what he dreams of getting. Should you be willing to pay that first price, woe betide you, for the value of everything else will be rated accordingly.

A TRIP TO THE YANGTZE VALLEY IN ANHWEI PROVINCE

On September 8, 1921, I boarded a southbound express train at Peking and proceeded to Wuhu and Ningkwofu in the Yangtze valley. The artist, Wong Hao-T'ing, who accompanied me, was making his first field trip. Only a few days before our departure, Mr. Wong had volunteered to go with me to record the colors of living animals in the field. Although he was already skilled in the technique of Chinese art, this was to be his initiation into the detailed and accurate methods of scientific drawing and painting. The cook, Wang, and "No. 1 Boy," Chow, completed our party.

Our object on this trip was to secure a large collection of the common Yangtze valley reptiles and amphibians, and this we succeeded in doing by October 20, when we left the Ningkwofu region, just a month after our arrival there. Contrary to popular belief, collectors want not only rare or new species but good series of common forms as well.

COLLECTING METHODS AT NINGKWOFU

Upon our arrival at Wuhu, a large city of Anhwei Province on the Yangtze River above Nanking, it was obvious that our work could best be done on a houseboat. After great difficulty due to the floods, we secured a suitable one and started on our way up a tributary of the Yangtze. The region was flooded and we were forced to go as far as Ningkwofu to find unsubmerged country. Here, with the houseboat as a base, we worked the surrounding area.

Common forms were bought from the local populace by my men, while I

made daily trips of discovery into the near-by hills. Local fishermen allowed us to examine their nets, and farmers brought snakes of all sizes to us in closed baskets. At times there was a line of men in front of our door, each man waiting with some reptile or amphibian to sell. One fisherman brought a turtle whose shell was covered with an aquatic growth and insisted that he had at last discovered the rare and valuable hairy turtle. He asked an enormous sum but in the end was glad enough to curb his ambition and to accept a more reasonable price. Sometimes it was necessary to allow oneself to be fooled to a degree in order to make the game of selling more exciting, and some of the specimens which we bought at the front door were thrown out of a back window. Occasionally, a disappointed customer hurled a snake upon the deck in disgust, but such displays of temper were unusual, because most of the natives considered our work a joke.

SNAKES OF THE NINGKWOFU AREA

The commonest snake of the Ningkwofu area turned out to be the little pit-viper, *Agkistrodon halys*. It was brought to us in such numbers that it soon became a menace. One example escaped, and only after several days did we discover it as it crawled from our boat to swim ashore. Two phases of this snake are common, a reddish and a brown phase. Aquatic snakes abounded in both field and stream. The water snake, *Natrix annularis*, frequented flowing streams, where it sunned itself on overhanging branches. I found one female giving birth to a litter of young on September 28. She produced eight brightly-colored offspring. The widely distributed tiger snake, *Natrix tigrina lateralis*, is another water-loving form, although it also wanders into dry places and does not depend on water for protection, as does *Natrix annularis*. The third aquatic species, *Elaphe rufodorsata*, is the common snake of open, flooded fields, where it literally swarms. Near Wuhu we found this snake so abundant that during a forty-five-minute walk we saw no less than six specimens. It is probably the most docile form of all those secured about Ningkwofu. I cannot recall having seen one attempt to bite, and once I picked up an example in the act of devouring a frog without even causing it to release its victim. Besides these three species that prefer the vicinity of water, the red-banded black *Dinodon rufozonatum* has some claim to being classed as semi-aquatic. The single specimen which I secured personally was caught by means of a frog tied to a long string. The snake, when first seen, escaped into a rock wall supporting a flooded terrace. Later it returned and swallowed the frog which I had left tied. The site of capture was very wet and muddy. I could not discover another example, but numerous specimens were brought in by the Chinese, proving it to be anything but rare. It is perhaps largely nocturnal.

From the point of view of behavior, the secretive two-headed snake,

Calamaria septentrionalis, is the most fascinating species found about Ningkwofu. In this species the head and tail are remarkably alike in both form and color. A captive specimen, when held by the tail, continued to try to escape. When its head was held to the floor, the whole body was instantly thrown forward, wrapped around the restraining fingers, and the tip of the tail repeatedly pressed against them. It seems that the tail takes the offensive while the head invariably tries to escape. The tail, in short, not only mimics the head in form and color pattern, but in behavior as well.

The extremely handsome and large *Elaphe tæniurus* was fairly common, but I was not fortunate enough to discover one myself. It has a placid temper and when once tamed makes a fine pet. I saw a snake-charmer in Wuhu who kept a good supply of this species in his baskets. Last, but not least, may be mentioned the fast-running field snake, *Zaocys dhumnades*, undoubtedly the most conspicuous Ningkwofu species of large dimensions. I found the capture of six-foot examples an exciting sport and sometimes flushed as many as five in a single day. This species prefers partly overgrown fields in the vicinity of groves of trees. There frogs abound, and *Zaocys dhumnades* delights in eating frogs, as I discovered on several occasions. Although a few other snakes occur at Ningkwofu, the eight forms mentioned above are the most familiar and interesting. The strikingly beautiful *Elaphe mandarina* escaped us entirely, so I must conclude that it is rare. I bought a tame example of this snake at Ningkwofu but could not be sure of its origin.

While writing of the capture of large snakes, it might be well to explain that we never used a gun in securing reptiles and amphibians, nor did we ever buy dead or mutilated specimens. This procedure proved to be good, as shown by the excellent condition of the many series collected. The local population quickly learns exactly what is wanted, and I am firmly convinced that, had we once broken our rule by purchasing a dead or mutilated specimen, we should never have been able to secure anything else. The fear of snakes, alone, would cause most people to kill a specimen before even attempting to catch it alive.

TURTLES, FROGS AND A SALAMANDER

In addition to the snakes, two turtles, *Geoclemys reevesii* and the problematic *Amyda tuberculata*, and eight frogs, *Bufo bufo asiaticus*, *Hyla immaculata*, *Microhyla ornata*, *Rana limnocharis*, *R. rugulosa*, *R. plancyi*, *R. nigromaculata* and *R. japonica*, proved to be common at Ningkwofu. A single species of salamander, *Triturus orientalis*, was also secured.

FISH FAUNA NEAR NINGKWOFU

Although the major part of our time and energy was devoted to the collecting of herpetological material, we also secured a good representation of the

local fish fauna. In addition to picking over the daily hauls of the fishermen, we visited numerous small fish shops and even spent a few days at Miaopu, a fishing village just below Ningkwofu, where we repeatedly searched through the fish brought in by a large fleet of boats. Thus we were able to collect some forty forms, four of which have been described as new to science by Mr. John T. Nichols and Dr. Henry W. Fowler.

TRIP TO TUNGTING LAKE, HUNAN PROVINCE

In December, 1921, we boarded a river steamer at Hankow bound for Tungting Lake, which is situated in northeastern Hunan Province. Tungting Lake is the largest lake of the Yangtze Valley and connects with the Yangtze River by a channel. Its seasonal rise and fall follow that of the Yangtze, and during the winter months the lake is little more than a broad mud-flat, crossed by rivers and streams.

A RARE RIVER DOLPHIN

I was directed by Dr. R. C. Andrews to go to the Tungting region to secure an example of the exceedingly rare river dolphin, *Lipotes vexillifer*, known locally as "Pai Ch'i" (white flag) in allusion to its light-colored dorsal fin. *Lipotes* was first made known to science by the late explorer and collector, Charles M. Hoy, who took a skull and cervical vertebræ to the National Museum in Washington. There Dr. Gerritt S. Miller recognized it as an undescribed relative of the South American fresh-water dolphin, *Inia geoffrensis*, and in 1918 described it as the type of a new genus. *Lipotes* and its few living relatives are the sole surviving remnants of a once widely distributed group of river dolphins. There is, then, little wonder that its discovery by Mr. Hoy was considered an event of no little importance in the history of mammalogy.

Shortly after my arrival at Tungting, I talked with local fishermen, who promised to secure for me a Pai Ch'i in the flesh. They lived up to their promise, and I was able to send news of my success to Doctor Andrews in Peking as a Christmas message. Unfortunately, the dolphin arrived on a dark, rainy afternoon and was photographed only with difficulty, but Artist Wong supplemented the photographs with color sketches of the freshly killed animal. A lifelike model is now on exhibition in the Hall of Ocean Life of the American Museum.

MAMMALS OF NORTHERN HUNAN

Reptiles and amphibians are scarcely in evidence during the winter months in northern Hunan, so my attention was turned toward work with mammals and fishes. The former were secured through local hunters and lines

of traps set out daily by taxidermist Kang. Muntjac and the common river deer of the Yangtze valley were easily secured, but of greater interest were the rodents and other small mammals caught in Kang's traps.

FISH FAUNA OF TUNGTING LAKE

Collecting fish at Tungting Lake was a highly organized process. Each year, as the waters of the lake rapidly fall, thousands of men gather to catch fish of all sizes. Their equipment ranges from small individual dip nets to long drag nets, requiring the coöperation of many men and boats. It is no exaggeration to state that scores of different kinds of nets are used. Some idea of their diversity may be had by consulting the excellent figures in Dabry de Thiersant's classic work, "La Pisciculture et la Pêche en Chine" (Paris, 1872). In the presence of the feverish activity shown by these swarms of men intent on making the most of a rapidly vanishing opportunity, there was nothing to do but step in and work along with them. A local boatman, Wan by name, was hired, and with him I spent much time going from fisherman to fisherman, examining the nets of all and selecting the various species of interest. This method was pursued for weeks. Occasional trips were made to the large markets of Yochow, but it proved far better to secure the specimens alive as they were taken from the water.

During this time Mr. Wong made many water-color drawings from living specimens. Among others, he was able to reproduce the brilliant colors of two new species of free-swimming loaches, *Botia citrauratea* and *Botia purpurea*. The bright colors of these armed fishes may have warning significance and are in strong contrast to those of the drab, eel-like, unarmed loaches of the genus *Misgurnus*, two new forms of which were also collected, *M. anguillicaudatus tungting* and *M. mohoity leopardus*.

Approximately seventy forms are represented among the fishes secured and twelve of these have been described by Mr. Nichols as new to science. This collection is especially valuable for the large and excellently preserved series of all but the rarest forms, and is complete enough to illustrate well the rich, specialized fauna of the Yangtze. The widely distributed, striped loach, *Cobitis tænia*, illustrates this specialization, for it is here represented by a geographic race quite unlike the forms of South China, Japan and Europe.

COÖPERATION OF HUPING COLLEGE FACULTY

While working at Tungting Lake, I lived with Mr. George Bachman, head of the department of natural sciences of Huping College. The late President Hoy, Mrs. Hoy, Mr. Bachman, Mr. and Mrs. Owen and many other members of the Huping faculty furthered the work of the Expedition in innumerable ways, and made my visit to the region pleasant as well as successful.

ALLIGATORS FROM WUHU IN THE YANGTZE VALLEY

On my 1921 visit to Wuhu en route to Ningkwofu, I found no trace of alligators. The region was flooded at the time, and the local fishermen assured me that at such periods it is extremely difficult, if not impossible, to secure specimens. Consequently, I decided to return in March, 1922. Upon arrival, I sent Chow on a scouting expedition, knowing that in the matter of buying he could make far better progress alone. After a few days, messages began to come in. He had located alligators at a point about seven miles from Wuhu on the banks of the Ch'ing Shui River, a stream which enters the Yangtze from the south at Wuhu. For some time reports as to the price per alligator improved, and finally, when the hunters had agreed to secure them for approximately one dollar gold apiece, I sent Chow word to close the trade. On the nineteenth of March, Chow strode into the compound ahead of a rickshaw loaded down with five securely bound alligators. Wang, my cook, returned with Chow to the site of capture and came back the following day, leading two additional rickshaw loads of alligators. My joy knew no bounds and I was soon on my way to the scene of action.

ALLIGATOR DENS

It was disappointing to discover that the specimens had been dug out while still hibernating in holes in the treeless river plain, and were as yet quite inactive. Chow added a little life to the scene by graphically illustrating how he, with the hunters, had chased down and captured barehanded a wildcat which had been found hiding in one of the alligator holes. Not only was this association of cat and alligator interesting, but also the fact that the barrenness of the surrounding plain had not afforded a suitable place for even a cat to hide. After studying and photographing the "dens," we returned to Wuhu with the last of our haul.

TRANSPORTING DORMANT ALLIGATORS

A few days later, on the express train to Peking, the warmth of the baggage car partly revived one of the alligators, and I was called from my seat in a coach to control the situation. I found frightened baggage men perched high on mountains of trunks and an alligator half out of the flimsy basket in which we had placed it, believing that it would remain quite inactive. Later, in the lobby of the historic Wagons-Lits Hotel in Peking, long-coated bellboys were terrified by this reviving reptile and again I was called, but this time at the inconvenient hour of six in the morning. The housekeeper, coming on duty and only about half awake, was confronted by an alligator wiggling toward her and her screams brought everyone within reach to her aid. Needless to say, these crocodilians were not "put up" in such stylish quarters a second night!

SURVIVAL OF ALLIGATORS IN A POPULOUS REGION

One cannot help wondering at the remarkable survival of *Alligator sinensis* in the midst of a region so densely populated, and this in spite of the fact that there is some commercial value attached to it. The ease with which hibernating individuals are dug up makes this survival even more puzzling. The only possible explanation lies in the assumption that they were once widely distributed and extremely abundant in the delta regions of eastern China. If this assumption is justified, the few remaining colonies must be looked upon as a mere remnant of a formerly enormous population. It is highly probable that *A. sinensis* once attained a much larger size than it does to-day. Remington Kellogg recently (1929) published evidence that the American alligator has already been greatly reduced in size by its ruthless persecution. When we consider the great rate at which the American form has been virtually exterminated in all open and inhabited districts, we can well admire the Chinese for having allowed even a remnant of its Asiatic cousin to survive for scientific study. The Wuhu region was settled by Chinese perhaps two thousand years before America was known to the white man.

RELATION OF CHINESE AND AMERICAN ALLIGATORS

The presence of members of the genus *Alligator* in central China and the southern United States, but nowhere else, has long been cited as a classic example of discontinuous distribution, and it has also been used to illustrate a degree of similarity between the fauna of eastern Asia and that of eastern North America. The degree of alliance between the American and Chinese alligators is, of course, a matter of great importance in determining the significance of the inter-continental relationship demonstrated by them. The most recent contribution to this subject is Doctor Mook's study, 1923, of the skulls of *Alligator sinensis* secured by the Central Asiatic Expeditions, as described above. Doctor Mook concludes that the Chinese alligator, though strongly resembling the Mississippi form in many respects, approaches a fossil species from the Miocene of Nebraska more closely, and that, therefore, the Chinese form may be considered more primitive than the American one.

Although it cannot be proved that *Alligator sinensis* stands in the direct line of descent of *Alligator mississippiensis*, the former may be definitely considered as partially bridging the wide structural gap between the recent American alligator and early Tertiary crocodilians. One must await the discovery of fossil alligators in China to establish this point. Doctor Mook believes that members of the genus *Alligator* represent a group that has been distinct from nearly all other crocodilians since Cretaceous times. Obviously, then, the broken distribution of the group and the scarcity of fossil forms leave their evolution almost a blank page in geologic history. The status of certain

fossil alligators reported from Europe is not definitely established. The presence of the two living forms in approximately the same latitude is a point not to be overlooked, indicating as it does a striking similarity in habitat preference.

SUIYUAN PROVINCE

In the spring of 1922 we set out for Suiyuan Province in northwest China. I had hoped on this trip to reach Ningsiafu via Suiyuan, but the unsettled political conditions forced me to be satisfied with working the region from Kweihwating to Paotowchen on the Yellow River.

In this region, reptiles and amphibians are not abundant, and we were able to secure only a few species. The fauna is essentially the same as that of northern central Asia, and the data obtained were chiefly of importance in helping to solve the problem of the extent to which this northern element penetrates into China.

FAUNA OF SHANSI PROVINCE

After completing the work in Suiyuan Province, I returned to Peking and prepared to collect in central Shansi. Headquarters were made fifty *li* south of Taiyuanfu in Feng Sheng Szu, a temple near Chin Tzu. From there, we collected as far north as Ningwufu. In Shansi, as in Suiyuan, we found the fish fauna of greatest interest, and ten of the twenty-eight kinds collected have been described by Mr. Nichols as new to science.

The number of forms of reptiles and amphibians brought together on this trip illustrates the contrast between the herpetological faunas of northern and of southern China. Only about fifteen species were secured in Shansi, whereas later, on our trip to Fukien, we found eighty species at a single locality. When Fukien has been exhaustively collected, we shall probably be able to list one hundred and thirty-five forms, or nearly seven times the number to be expected in Shansi. These figures compare a rich oriental with a sparse palæarctic fauna, and the contrast is, of course, great.

VALUE OF A KNOWLEDGE OF THE CHINESE LANGUAGE

My first trips had taught me how necessary it is to know Chinese if one is to collect successfully in China, and I therefore devoted much of my spare time to the written as well as the spoken language. I found this knowledge of inestimable value during my subsequent work in Fukien. In fact, when working in Shansi, I had fully made up my mind to visit every province and considered the time spent on the language an investment to be drawn upon in the future. Contrary to general belief, the dialects of China do not present an insurmountable hardship to the foreigner, because the really difficult ones are confined to a very narrow strip of coast extending from Shanghai to Canton,

a region of relatively small importance to collectors. By way of illustration, I shall cite my experience in Fukien, which is a mountainous province noted for its alleged many dialects, their number often being placed at thirty. About Foochow and on the coast in near-by Futsing Hsien, I was unable to talk to the farmers, but at Yenping, only ninety miles from the coast, a dialect quite intelligible to me was prevalent. More surprising still is the fact that in the wild mountains of the northwestern border region of this province, I again experienced little difficulty in making myself understood, and this in spite of the local population having come originally from extreme southwestern Fukien. I do not intend to give the impression that the dialects of China are not troublesome, but merely to say that modifications of one language, generally referred to as Mandarin, are spoken over nearly all of the area formerly called the "Eighteen Provinces" and that these modifications do not present great difficulties to collectors and other scientific investigators who require only a small vocabulary. My right to generalize is based upon experience in seven provinces, ranging from the edge of Mongolia in the north to Hainan Island in the extreme south and as far west as Hunan and Shansi. These facts are set down in the hope that they may be useful to future workers, who, doubtless, upon arrival in China will be told that it is folly to attempt to learn Chinese for practical purposes. I shall never regret having entirely disregarded all such advice. Moreover, any characters learned will be perfectly understood over the entire twenty-eight provinces of China, all of Japan, much of Outer Mongolia, French Indo-China, Siam, Burma and the East Indies as well.

CHAPTER XLVI

ISLAND OF HAINAN, 1922–1923

By Clifford H. Pope

JOURNEY TO HAINAN

Early in November, 1922, I left Peking with Artist Wong, Assistant Wang, and two taxidermists, Kang and Chang, bound for the island of Hainan, which is China's southernmost territory.

On the fifteenth day after our departure, we disembarked at Hoihow, Hainan's only port. I soon decided to head for Nodoa, a small inland town situated in the hilly country intermediate between the island's rolling northern plain and its wild southern highland. Members of the Hoihow branch of the American Presbyterian Mission not only gave much-needed advice, but actually hired a boat that would take us to Fa Hi, the head of navigation on the Golden River. We reached Fa Hi after three days of slow traveling up the river, and then a two-day journey overland brought us to Nodoa.

COÖPERATION OF MISSIONARIES AT NODOA

Late one afternoon, after a weary day's march through rolling, bushy country, we saw foreign houses on a low distant hill, and beyond, blue mountains standing out against the sky. Our porters made a bee-line for these houses, not even waiting for directions. Of course, foreigners were coming to see foreigners! Once inside the mission compound, I was greeted by name and told that my dinner would soon be ready. The missionaries at Hoihow had sent a message and so we were expected.

The late Rev. William J. Leverett showed me a room that he said was to be mine and also an empty one in which we might store our equipment. In time, not only half of his bungalow had been turned over to us, but also various rooms in other buildings. We even invaded the hospital compound and before we were ready to leave, it seemed to me that we had used, in some way or other, every bit of the entire compound. Doctor Salsbury's assistant very patiently put up with bad odors resulting from the preparation of bats, rats,

porcupines, hares, muntjacs, mongooses, genets, wildcats, wild pigs, monkeys, a varied assortment of squirrels, and many other mammals, all of which took place in the room next to his.

DIFFICULTIES OF WORK IN HAINAN

My thankfulness increased and also my surprise, for the Peking Chinese had only discouraging tales to tell of the supposedly dangerous interior. It is said that the Hainanese have short tails and live on snake meat. Even in Hoihow it was hard to get a "boy" sufficiently venturesome to make the journey with us as interpreter. The one we finally induced to accompany us proved, before the end of a week, to be unable to cope with the local dialects and was therefore useless. We soon learned something of the difficulties. In Nodoa, which is the district's market town, five distinct dialects are spoken—one for the town itself and one for each point of the compass. The so-called Mandarin spoken by the people of Nodoa is a corrupt form of the northern language. Hainanese, Hakka, Domchiu and Lim-ko Loi, Cantonese, and the local Mandarin all may be heard on the one "street." The missionaries have to study three and four dialects.

AH-SEN, GUIDE AND INTERPRETER

Mr. Leverett, anticipating my need for a local man to act as both guide and interpreter, had engaged Ah-sen, one of the old, faithful servants of the mission. During the following months Ah-sen handled nine dialects for me. Some of these could justly be called distinct languages. He could not write Chinese nor could he speak a word of English, but he knew a little northern Mandarin. No other Chinese in the district could speak so many dialects, nor was any quite so courageous as Ah-sen. He was invaluable. While with me, he had two encounters with bandits and congratulates himself on having come through with his life and without having taken that of a single bandit—a distinctly Chinese way of thinking. Ah-sen was famous for two exploits: once he had carried water bare-footed and bare-legged—but with an old, high silk hat balanced on his head! On another occasion, in his "table boy" days, he had appeared at dinner, tray in hand, and a discarded corset drawn snugly about his waist.

METHODS OF COLLECTING FISH

Through the cooler winter months we spent most of our time studying and collecting mammals, but before February had passed, hot weather set in and we turned our attention to reptiles, amphibians and fish. There were some days of warm weather before the endless rains began, and during these few days fish collecting was good. All the creeks and small rivers were so

low—a result of the dry winter weather—that the fish were trapped in the deeper pools. Local farmers raced with us to the best places. They dumped quantities of lime into the water and thus forced the fish to the surface. Only a few days of the mild weather had passed when the spring rains came down; the thin trickles of water that barely connected the pools became torrents, and the fish that had escaped dynamite and lime were liberated.

ACTIVITIES AT NODOA

With the mission compound for a base, ponies at our disposal and the missionaries ever ready with advice and help, we were fortunate indeed. Kang and Chang were busy setting out and taking in traps, bargaining with local hunters and skinning, while Wang was occupied with the boys, many of whom had become expert in catching snakes and frogs. A local man had been hired to help with the trapping and had himself become a good trapper. One day he put down his bag and, cautiously opening it, took out a rat trap in which a large cobra was securely caught by the neck. Ah-sen was kept more than busy hunting and circulating the news among local hunters that the new foreigner at Nodoa would buy all kinds of animals. If the village people were not reminded frequently, they would stop bringing in their catch. Two large cloudy leopards were killed and eaten on a mountain only seven miles from Nodoa. When Ah-sen asked the hunters why they had not brought the animals to us, the men said they had not been sure that we wanted leopards.

BARGAINING WITH HAINANESE FARMERS

In the case of animals having a set market value purchasing was easy, but when it came to buying an uncommon toad or lizard or snake, the problem was far from simple. Any little slant-eyed boy would be glad of the chance to earn the fraction of a cent by gathering a few common frogs, but if a large or rare creature was brought in by a farmer, we hardly knew what to do, and generally left the decision to Wang. Under such circumstances, Wang, apparently not even deigning to turn from his work—thus appearing to be as unconcerned as possible—would quickly size up the object by glances out of the corner of his eye. The captor of the prized specimen would, on his side, lose no time in trying to impress Wang with the scarcity, difficulty of capture and good condition of the animal. The next stage would be an effort on the part of each to force the other to name a price first—neither having the slightest idea of the other's conception of a fair figure. After some moments of deadlock, the one finally forced to name his price would be certain to have to bear the fierce sarcasm of the other. For instance, if Wang had, as a starter, offered fifteen cents, the farmer would immediately have appeared to be either mortally wounded in pride, overcome with burning disgust or choked with convulsive

laughter at the very idea of such a ridiculously low price. If the farmer had been forced to name his price, Wang in his turn would have shown similar symptoms of varied and violent emotion. After many minutes of alternate emotional explosions the purchase would be concluded by Wang shouting after the fast-disappearing and thoroughly disgusted Chinese that his last price, though ridiculously high, would be given because—and here would follow a long series of apologetic and conditional excuses for giving in, duly punctuated with anything but complimentary remarks about the mental, moral and physical make-up of Hainanese in general and one snake-catching farmer in particular. In all such bargaining the figure finally arrived at is sure to be about half-way between the two original conceptions of value. One wonders why it would not be simpler at the very start to subtract one figure from the other, divide the difference by two, and add the result to the smaller sum, thus arriving more promptly at the inevitable half-way point.

PROBLEMS OF ARTIST WONG

Through all the many ups and downs of our efforts while on Hainan, Artist Wong worked steadily, never for an instant becoming slack. He drew with a steadiness that only an Oriental can show. One afternoon he came up to me with a most worried expression—something unusual for him—and told me that the toad on which he was working appeared to be seriously ill—yes, but he hardly dared breathe it, the creature was already almost dead! I hurried with him to see just what could be the trouble. Sure enough, there it lay all rigid, its legs stretched out in a pitiful manner. Could it be that the toad had actually "passed on"? Then Mr. Wong began sadly to relate how it had happened.

"About an hour ago," said he, "the toad began to scratch its sides and rub its mouth in a peculiar way. I couldn't imagine what was wrong. 'Surely it is suffering or is very sick,' I thought. Soon a thick substance began to ooze out all over its body. This puzzled me still more. Then I saw what I could hardly believe—tears appeared in its eyes and I told myself that the poor toad must be actually crying. I felt sorry for it and said—'That's all right; don't cry, don't cry—you mustn't cry!' "

All his encouragement failed, however, to save its life, for the creature had been chilled while shedding its skin. But how should Chinese artists know that toads shed and eat their skins?

When first asked, more than two years before, if he would go in the field with a foreigner to draw living animals, Mr. Wong wanted especially to know whether he would have to handle snakes. That was one thing he could not do. Therefore, it was most amusing to see him lovingly caress and nurse a little snake he was drawing, after two years' experience.

PLATE CIX.

A. A CHINESE COBRA.

Cobras are common on the Island of Hainan where this specimen posed for its photograph.

B. THE PIT-VIPER, *Agkistrodon monticola.*

It was found guarding its eggs in the mountains of northwestern Fukien.

C. C. H. POPE AND NATIVE COLLECTORS.

Specimens were frequently brought in by crowds of curious farmers who often stayed to watch identification and preparation.

PLATE CX.

A. A CHINESE ALLIGATOR

This torpid alligator was found in a state of hibernation in a low cave in the Wu Ling Mountains, Province

B. THE YANGTZE FRESHWATER DOLPHIN, *Lipotes vexillifer*

This species was not known to science until 1918. One of the very first specimens procured for scientific study is shown here

C. A LARGE PIT-VIPER OF CENTRAL CHINA.

The mild and docile nature of this snake belies its appearance. This specimen was taken in northwestern Fukien.

D. HAINAN ISLAND PORCUPINE.

One of the new subspecies collected was this porcupine, *Acantion subcristatus papæ*.

A remarkable and beautiful tadpole, its body a mixture of rich browns, was brought in. On its back was a delicate pink frill which even the weakest current swayed. The two tiny legs with their fully webbed feet were kept moving in an unusual manner—not as ordinary polliwogs are wont to move theirs. Mr. Wong became interested at once. Surely this tiny creature could not be merely a tadpole; certainly it was the child of some weird dragon! So, day by day, as he watched the development, Mr. Wong gave rein to his fancy. What manner of strange dragon would it turn into? Its parents were certainly hidden deep in some wild jungle! But alas, what disappointment! As the limbs slowly developed, the rich colors blended and faded, finally disappearing altogether. Ordinary shades of dull green gradually appeared and the head became decidedly "froggy." All Wong's dreams were shattered. We had before us only a tiny, ugly specimen of the commonest frog on Hainan, the frog that nightly makes the air alive with its incessant calling from the paddy fields.

INDIFFERENCE OF HAINANESE TO SUN AND RAIN

The intense heat and the violence of the sudden storms made work during the day difficult. Foreigners who have lived in Indo-China and latitudes as far south in the Orient well know how carefully the newcomer has to guard against the heat of spring and summer, yet one often passes Chinese working while the noonday sun beats down upon their bare, shaved heads. The Chinese sometimes catch small fish and snails by bailing out shallow swampy stretches. This they will do in the middle of the day under the hottest sun.

Often a whole village will appoint a time for fishing and, putting aside farm work for the day, descend upon a stream, shut off a section from above and below, and then make a raid on the fish, the men working in the deeper pools with nets and the boys among the rocks and grass in the shallows. As the day goes on, the fish become more and more exhausted from constant fright and gradually fall victims to either the boys or the men.

In the preparation of the rice fields it is necessary for the men to wade around in the soup-like mud of the flooded fields for hours and one soon becomes convinced that the skin of these farmers must be as water-proof as their heads are sun-proof.

ACTIVITIES OF OUTLAWS

The hot season, when work in the day was most difficult, coincided with an increase in danger from local outlaws who rendered night work hazardous. All roads through the scattered patches of jungle were carefully guarded and kept clear of stragglers at night. One was more apt to be shot for a robber

than taken by robbers, and the local people could scarcely be persuaded to go about after dark. Nevertheless, I worked with little restriction and was never personally molested or threatened. The most severe complaint that I can make against the lawless elements was the theft of some specimens—a Loi collector on his way to Nodoa with several turtles having been stopped and relieved of the only edible ones in his catch.

FISH, AMPHIBIANS AND REPTILES OF HAINAN

Our collections had steadily grown and considerably more than a hundred species of reptiles, amphibians and fish were represented. The fish collection turned out to contain a remarkable number of novelties, about one third of the species now known from Hainan having been based on our material. The reptiles and amphibians secured included 1580, representing forty-nine species. Fifteen of these had never before been recorded from Hainan and three proved to be new to science. The acquisition of this collection stands as another milestone toward a knowledge of the herpetological fauna of southern China. It contains invaluable material for comparison with that of the even richer collections made by R. Mell in Kwangtung (1929) and, more recently, the Sun Yatsen University in Kwangsi. When these three collections have been adequately compared, the herpetology of southern China will be understood quite as well as that of any other area in the same latitude.

MAMMALIAN FAUNA

Eleven hundred and fifty mammals, representing nearly fifty forms, were brought together. The most striking of these was the giant flying squirrel, *Petaurista hainana*. This magnificent creature reaches surprising dimensions, the type specimen measuring slightly over forty-one inches from tip to tip. The dorsal surface is a grizzled rusty black. It is surprising that former collectors have not secured examples, because the Miao hunters shot a fine series for me without great difficulty. These same hunters found the large *Ratufa gigantea hainana* exceedingly hard to kill, so it is readily understandable why this gigantic squirrel is known only from the type described twenty-six years ago and the single specimen secured by me. A small flying squirrel, *Pteromys electilis*, taken in great numbers not far from Nam Fong, proved to be new to science also. Thus, three of the five squirrels found are of extraordinary interest.

Eight forms of the genus *Rattus* were taken, two of which are new, *R. rattus hainanicus* and *R. confucianus lotipes*. More interesting, however, was the discovery of the genus *Hapalomys* on Hainan, constituting, as it does, an addition not only to the fauna of Hainan but to that of China as well. The new species, *H. marmosa*, described from a single specimen, was taken near

Nodoa. Members of this genus of small rodents are arboreal, the grasping hind foot recalling that of the opossum.

Muntjacs have been known from Hainan since Swinhoe's time, 1869, but sufficient material for the exact determination of the species has never before been secured. Dr. Glover M. Allen, 1930, named the Hainan form *Muntiacus muntjak nigripes*. It is characterized by its small size and dark legs.

The Hainan pangolin, *Manis pentadactyla pusilla*, originally described as "very small," is shown to be fully as large, by the series secured, as those from Fukien. These animals were common about Nodoa where our lot was collected. The porcupines brought to us by local farmers also turned out to represent a previously undescribed insular form, *Acanthion subcristatus papæ*. It is smaller and darker than the typical one.

END OF WORK IN HAINAN

Early in July, news of the reassemblage in Peking of the members of the Central Asiatic Expeditions reached me and I prepared to leave Hainan. It was not easy to part with the good people who for so many months had helped me in every way. Each foreign member of the mission, as well as numerous Chinese hunters, farmers and traders, had helped to make our efforts fruitful and our life pleasant.

CHAPTER XLVII

FUKIEN AND KIANGSI PROVINCES, 1925–1926

By Clifford H. Pope

IMPORTANCE OF FUKIEN FOR HERPETOLOGICAL COLLECTING

In northern Fukien the collector may secure herpetological specimens characteristic of India, Indo-China, Siam and Malaysia, as well as those typical of northern China, Korea and Manchuria. The king cobra is an example of the former, while the common north China toad typifies the latter. Moreover, the relatively unspoiled nature of this rugged, mountainous province attracts the explorer and the collector alike.

In spite of the fact that the Rev. Harry R. Caldwell had already made small but rich collections of fishes for the Central Asiatic Expeditions in Fukien, I determined, upon my return to China in 1925, to proceed at once to Foochow and begin a survey of the Min River valley.

NATIVE HELPERS

At Foochow I was fortunate in securing, through the help of Dr. Franklin P. Metcalf of Fukien Christian University, the services of Ch'en Ti-Ti, Mr. Caldwell's well-known tiger-hunting cook, generally known as "Da Da." I had brought with me, from Peking, artist Wong, Hao-T'ing, taxidermist, trapper Kang, and assistant Wang Fa-Hsiang. Within the next few months these last-named men had to return to northern China for various reasons, but I was fortunate in being able to replace them by local men, chief among them T'ang Ch'i-Hsiu, a member of the famous Foochow T'ang family, collectors of international reputation.

ASSISTANCE OF MISSIONARIES

After waiting through several days of discouraging rains, we boarded a motor launch and started up the Min on our way to Yenping, where, on April 11, we were welcomed by Dr. Charles Garnet Trimble and his two boys, Edward and Robert. Dr. and Mrs. Trimble not only put me up in their house but furthered my work in innumerable ways throughout my sojourn in Fukien.

Several other members of the Yenping Mission were also very cordial and helpful.

COLLECTING NEAR YENPING

Yenping itself is an ideal base from which to collect. The city stands at approximately five hundred feet above sea-level while the mountains immediately behind the city rise to some 4,000 feet, thus giving the collector a considerable range of altitude to work.

Following Dr. Trimble's advice, we made our headquarters in Hsiyuankeng, the deep and wild gorge just above Yenping, where we found a temple conveniently situated in which to live. Although we were ideally located, the extreme steepness of the gorge and incessant rains made work difficult. The small population from which to secure helpers in Hsiyuankeng village made it necessary to do most of our own collecting and it was therefore impracticable to obtain large series of many of the local species. Nevertheless, the few villagers with time to spare showed great interest in helping us and, as the weather cleared, our work improved considerably.

BREEDING OF THE TREE-FROG, *POLYPEDATES DENNYSI*

After six weeks spent near Yenping, I decided to proceed up the Min. We had already brought together nearly sixty forms of reptilian and amphibian life, as well as smaller collections of mammals and fishes. I had been able to observe the breeding of the giant green tree-frog, *Polypedates dennysi*, on a bush growing over the temple spring. This handsome frog is so thoroughly adapted to an arboreal life that it does not even descend to breed, but suspends its eggs from leaves and twigs as a pear-shaped mass of sticky, elastic foam three to eight inches in diameter. I have recently described the deposition of one of these foam-nests, as follows:

"Low, thick clouds and a heavy rain, on the afternoon of April twenty-fifth, shut out most of our light and made the middle of the afternoon resemble dusk. Several *P. dennysi*, confined in a bucket near the spring, began to call, and soon their calling was answered from the drenched bamboo groves surrounding the temple. The answers grew more and more numerous and one could make out large forms leaping about the temple yard. By five o'clock the frogs were present in great numbers and very obviously trying to pair off, but the dim light and their extreme agility prevented my following their movements closely. Soon I saw a mated couple near the bush which was growing over the spring.

"The downpour continued, but by eight o'clock a mated pair had ascended the bush and begun to lay on the leaves of a limb which was overhanging the spring. During the process other males moved restlessly about over the

embracing frogs, and indeed, on the same bush at another time, I saw a mass of at least six frogs clinging together about what appeared to be a single female

"The laying pair were not greatly disturbed by intermittent light and I was able to observe some of the details of the process. The grasp of the male was axillary, while the female clung to the leaves of the bush with her forelimbs. The male held his feet together with their dorsal surfaces pressed against the posterior end of the female's body, but at regular intervals he slid them dorsally, bringing their upper surfaces against the end of his own body for a very brief instant, after which they were returned to their original position against the female. The female on her part was now resting, now moving her feet around and around in a paddling motion over the surface of the leaf just behind the pair. The two sets of motions seemed to be correlated thus: the beating was begun by the female, the shuttle-like motion of the male following the first few beats. All the movements were quite mechanical and deliberate. The female's center of beating was shifted to some extent but the male did not take part in it. Intervals of rest followed twelve to fifteen strokes as a rule, but there was much variation in this respect. Unfortunately, the great size of the male's feet prevented any observations on the actual process of egg and mucus expulsion but the steady increase in size of the froth-mass on the leaf below proved that expulsion was taking place. The whole process lasted about four hours."[1]

KUATUN, A FAMOUS COLLECTING LOCALITY

Our objective upon leaving Yenping was the scientifically famous collecting ground known as Kuatun, or Kaotén, located in the high mountains separating northwestern Fukien from northeastern Kiangsi. Kuatun was made known to science through the work of Abbé Armand David, 1875, the well-known French explorer of China. He visited the village in 1873 and secured so many unique specimens that Mr. J. D. La Touche[2] went there in 1896 and again 1898. La Touche's collections in turn contained enough new material to prove that this veritable mine had by no means been exhausted. Since 1898, members of the T'ang family had repeatedly visited Kuatun and this remote village became the type locality of innumerable species of animals. It is only fair to state at this point that Robert Fortune[3] crossed the northern Fukien-Kiangsi boundary on his way from Hok'ou to the Bohea Hills (Wuishan) in 1849, and remarked on the size of the mountains separating the

[1] Pope, Clifford H. 1931. "Notes on Amphibians from Fukien, Hainan, and Other Parts of China," *Bull. Amer. Mus. Nat. Hist.*, LXI, Art. 8, pp. 565–566.

[2] Boulenger, G. A. 1899. "On a Collection of Reptiles and Batrachians made by Mr. J. D. La Touche in N. W. Fokien, China," *Proc. Zoöl. Soc. London*, pp. 159–172.

[3] Fortune, Robert. 1853. "Two Visits to the Tea Countries of China." John Murray, London. II, pp. 28–47.

provinces. His observations influenced later explorers to visit the region. W. Limpricht, 1914, has more recently given an interesting account of his brief visit to the same general region.

We left Yenping on a boat June fifth and arrived at Ch'ungan City the eleventh. From there we went at once to near-by Hsing Ts'un, one of the famous tea-collecting centers for the Bohea Hills. After working a few days at Hsing Ts'un, I proceeded with Da Da on the twentieth by foot to enter the mountains to the northwest. At two P. M. of our second day's walk we reached San Chiang, a village at the base of Kuatun Mountain and a long hour's climb from Kuatun hamlet. The local inhabitants gave us a warm welcome and, in strong contrast to the population of Hsing Ts'un, seemed to be anxious to collect for us. Unsettled times had prevented the T'angs from visiting the region for years, but, surprisingly enough, most of the villagers recalled collecting in the past and some even remembered La Touche's visits of 1896 and 1898.

Early on the morning after our arrival, a boy voluntarily appeared with a snake tied to a stick. We had at last aroused genuine response to our call for specimens and, indeed, from then on specimens came in as fast as one could have wished. Seven days in the week found us busy from daylight to long after dark or even well on into the night. Although we slept at San Chiang, the Kuatunites made daily visits to bring specimens.

Although deforestation is in progress in the open valleys about San Chiang, the higher mountains are still forested, and it is doubtful that enough damage has been done to affect the reptile and amphibian life of the region. Kuatun village is little more than a series of houses widely scattered along an elevated valley, bowl-shaped at its upper end and terminating high on the side of Kuatun Mountain. The industrious villagers grow tea, hunt, dry bamboo shoots and prepare bamboo fiber. The dried shoots and fiber are taken down to one of the nearest market towns and sold, the former for food, the latter for the manufacture of paper. The growing of tea plants necessitates a certain amount of deforestation, but the bamboo industry preserves the bamboo forests, many of which are carefully watched and worked.

AN ISOLATED ROMAN CATHOLIC COMMUNITY

Kuatun is also interesting as an isolated Catholic community. The story goes, and I believe it is quite authentic, that early in the nineteenth century a Catholic colony of extreme southwestern Fukien was scattered by a wave of opposition to the Catholic Church. One man escaped alone and, in an effort to avoid detection, made his way northward through the wilder sections lying along the Fukien-Kiangsi boundary, until, arriving at a region entirely uninhabited and covered with virgin forests, he built a hut for himself and settled

down as a lone pioneer. Being Chinese, he wanted a family and found little difficulty in persuading some of the inhabitants of an outlying valley in the foothills to give him a wife. After that, wives were frequently brought in, but husbands never. Thus, a Catholic community grew and prospered, keeping the faith without opposition. Eventually communication with Foochow was established and a resident priest sent to this unique and spontaneous colony. Abbé Armand David doubtless learned of this particular village through its unusual origin, and so once more religion and science have been of mutual benefit.

RETURN FROM KUATUN TO FOOCHOW

About the middle of July a slight infection of my foot grew worse and, because of it and also a desire to work in the general region of Foochow before winter, I decided to return to the coast. Thanks to the older methods of transportation still prevalent in Fukien, I was able to travel entirely by chair and boat, thus saving my foot, which was now dangerously infected. We left San Chiang July twentieth and reached Yenping the twenty-sixth, where I underwent treatment for several days at the Mission Hospital. Doctor Trimble and his family were away and only Mr. Bankhardt was present at the Mission. Da Da went back to Hsiyuankeng to collect for a few days and Kang also returned to a former trapping site, Shihsunkeng. Our subsequent return to Foochow, my visit to Doctor Trimble's summer home on Kuliang Mountain, and our journey to Lingshihszu in the mountains of Futsing Hsien, consumed much time and we did not reach our destination until August twenty-fourth.

FUTSING HSIEN AND THE LINGSHIHSZU MOUNTAINS

Futsing Hsien lies on the coast immediately southeast of Foochow. This district with its low, level plains is nearly everywhere well populated. The few rugged mountains that cut across the plains are covered with grass, scrub evergreens and dense thickets. Lingshihszu or "Spirit Rock Monastery" lies within a bowl-shaped valley encircled by steep, rugged mountains which are in the process of being deforested. Adverse times have forced this monastery to sell its forests, and before long it, too, may lie in a devastated area devoid of all large trees. The mountain streams above Lingshihszu are still inhabited by a reptile and amphibian fauna essentially similar to that of the Kuatun region, while the neighboring ranges have only dry stream-beds extending down forlorn ravines.

REPTILES AND AMPHIBIANS OF THE LINGSHIHSZU MOUNTAINS

The few villagers of the Lingshihszu Mountains proved to be willing helpers and our collections grew rapidly. In fact, the number of species secured

PLATE CXI.

A. A CHINESE RIVER BOAT.

This boat, like countless others in China, is especially adapted to the river for which it is built. We used this one on our trip to the mountains of northwestern Fukien.

B. KUATUN MOUNTAIN, NEAR THE KIANGSI BOUNDARY OF NORTHERN FUKIEN.

It is scientifically famous as the type locality of scores of animals. Its summit is approximately 7,000 feet above sea level, and its flanks are well forested.

A. A VIEW OF THE TOP OF ONE OF FUKIEN'S HIGHEST RANGES TAKEN AT UPPER KUATUN.
A tea field and bamboo grove appear in the foreground

B. THE BOHEA HILLS (WUISHAN), FUKIEN PROVINCE.
These hills are no less famous for their tea than for their scenic beauty.

here and at near-by Foochow fell little short of the total for Yenping, and this in spite of the relatively unspoiled mountains at Yenping. An explanation of the wealth of the Futsing fauna lies partly in the presence there of tropical forms unknown at Yenping. The small, aquatic field frog, *Oœidozyga lima*, may be cited among the frogs, while the king cobra is the most conspicuous example among the snakes.

It was most gratifying to find Barbour's watersnake, *Natrix æquifasciata*, 1908, abundant in the streams that flowed in front of Lingshihszu. This reptile was discovered on Hainan and its validity as a distinct species questioned later. In habits as well as pattern it is a very distinct form. Unlike the other local watersnakes, it suns itself on bushes overhanging flowing streams into which it dives when alarmed. This behavior strongly suggests that of certain semiaquatic snakes of the United States, also members of the widely distributed genus *Natrix*. *N. æquifasciata* attains a large size. One female brought in measured six inches in circumference and slightly over four and a half feet in length.

MAMMALS OF THE LINGSHIHSZU REGION

Toward the end of September our work with the amphibians and reptiles of Futsing Hsien was brought to a close. The weather had become much cooler and specimens became increasingly difficult to secure, until we could scarcely expect to add anything of interest to our collection. On October fifth we moved out of the Lingshihszu Mountains and into a temple at the base of a neighboring deforested range. Although our traps had yielded some interesting mammals, on the whole it seemed almost impossible to collect them in large numbers in a region as wild and steep as that immediately surrounding Lingshihszu. I proposed to secure large series of all the mammals of the district, both common and rare, and with this end in view stopped all reptile, amphibian and fish work, hired three hunters to help Da Da and turned full attention to hunting with dog and gun in the more open mountains and valleys.

Our method of hunting was the simplest possible. Da Da's familiarity with the region enabled him to select the best local hunting-dogs, and these proved to be an indispensable part of our outfit. After selecting a likely ravine, all the hunters but the one chosen to control the dogs posted themselves at vantage points around the upper end and waited for the dogs to drive the animals out. Working with some house or temple as living quarters, we exhausted all the ravines within easy walking distance before shifting to some other section a few miles distant. Thus we were able to cover a considerable area.

The results showed that the above method was most effective for wildcat,

civet, muntjac, fox and mongoose, but less so for certain other common mammals. These were, in part, secured by various supplementary methods. In the course of time, we succeeded in bringing together about thirty-four forms. In studying the collection, Dr. Glover M. Allen has found the large series of common forms especially valuable in his work of determining the range of variation within certain species. Many questionable names have been duly relegated to synonymy, while a single new form was brought to light, *Helictis taxilla sorella*, 1929, a ferret-badger.

TIGERS

Before our departure from Lingshihszu a leopard had killed a goat in broad daylight within a stone's throw of our monastery, and rumors of tigers were prevalent. Although the presence of tigers in the immediate vicinity tempted us all to devote our efforts to hunting them, I was determined to stick to my original purpose of securing a general collection of mammals, not allowing myself to be lured into the uncertain game of tiger-hunting. But it was thrilling to realize that we were on the very scene of so much of the active and dangerous hunting in which Da Da had taken part. It was upon his prowess as a tiger hunter that Da Da had been recommended, he having helped Caldwell kill more than twenty tigers. This was done not from the safe protection of a raised platform but hiding behind flimsy blinds constructed near the place where a tiger was known to be lurking. In his interesting book, "Blue Tiger," Caldwell tells of one of these dangerous adventures, as follows:

"The most nerve-racking experience I have ever had in a tiger's lair was when I foolishly entered the lair of a tigress with three small kittens, one of which had been captured by some wood choppers the day before. The mother cat in her grief and anger had clawed great holes in the ground and attacked trees, which she had gnawed to shreds as high as she could reach. No human maniac could have torn things up any more than that enraged tigress had.

"I found the remains of a pangolin which had been torn to bits and scattered about. The only thing that saved me probably from just such a fate was the fact that the lady of the place had given up hope of finding her lost child and had moved out with her remaining two."[1]

PACKING SPECIMENS FOR SHIPMENT

We continued to hunt in full force through October, December and January, and to a limited extent during November and parts of February. I spent several weeks of these last-named months in Foochow packing the collections for final shipment. The reptiles and amphibians were easily packed,

[1] Caldwell, Harry R. 1924. "Blue Tiger." The Abingdon Press, New York. P. 97.

but the mammals offered some difficulty. The dampness of the Foochow winter and early spring months made it necessary to wait for suitable days when the skins could be dried sufficiently to avoid moulding en route. Some months before, Da Da had taken me to Mrs. Lydia A. Wilkinson's house near Huanan College. There I was made to feel perfectly at home. Moreover, Mrs. Wilkinson turned over to me her large porch and yard as drying and packing headquarters and good-naturedly allowed me to litter both porch and yard with thousands of specimens, many of them extremely unpleasant to more than one of the five senses.

SECOND TRIP TO NORTHWESTERN FUKIEN

After thinking matters over carefully, I determined to return to the San Chiang-Kuatun region and try to complete my collections from there. My brief visit of the previous summer had convinced me that the surface was barely scratched. With this purpose in view, I again left Foochow. April sixth found us back at Yenping, where we were warmly greeted by the Trimbles, and I spent another enjoyable week with them. Boats proved to be extremely hard to secure, but we finally found one and left Yenping on the twelfth, arriving at Ch'ungan City the eighteenth and San Chiang the twenty-fourth. Here we were received with open arms by our former helpers and friends. In less than no time, numbers of these people had promised to collect for us, even more vigorously than on our previous visit.

COLLECTING MAMMALS AT SAN CHIANG

Several men were especially anxious to hunt the larger animals and, in fact, did so with so much success that when we left early in September about forty species were represented in our mammal collection of more than two hundred and thirty specimens. We had secured a series of the common rhesus monkey of southern China and Hainan, *Macaca mulatta*, as well as several examples of the little-known stump-tailed macaque, *Lyssodes speciosus melli*. The beautiful golden cat, *Felis temmincki dominicanorum*, and the common bear of southeastern China were also represented. Our hunters had killed pig, serow and muntjac for us, while among the smaller mammals we had secured the aquatic shrew, *Chimarrogale leander*, and the rare brush-tailed mouse, *Typhlomys cinerea*. The rabbits collected have been described by Doctor Allen, 1927, as a new subspecies of the common *Caprolagus sinensis* of southern China.

The methods used by these hunters were varied. The most successful of them, Fu Yu-Fa, spent many days hunting pigs and monkeys by simply walking through the forests, gun in hand. He also set snares for serow. Others constructed small deadfalls, snares and bamboo traps with iron jaws. Fu

Yu-Fa and one other Kuatunite had each built a tiger trap adjoining his pig-pen, but no tigers were taken during our stay. In fact, tigers were said to be exceedingly rare in the Kuatun region.

COÖPERATION OF NATIVE ASSISTANTS

This time my party included only Fukien men, T'ang Ch'i-Hsiu, T'ang Jui-Chin, Ch'en Fu-T'uan, Ch'en A-Mei, and, of course, Da Da—taxidermist, reptile and amphibian preparator, cook, trapper and hunter, respectively. Throughout our trip these men coöperated with me as well as with one another in every way possible, and I doubt if a better team of workers could have been brought together. Although all of them spoke the Foochow dialect as their native tongue, Taxidermist T'ang, Da Da and Fu-T'uan were familiar enough with Mandarin to get along in upper Fukien where it is spoken by everyone. I considered myself fortunate in having no English-speaking assistants, for I had long since learned through experience that it is infinitely better to use the language of those among whom one works.

My visit of the previous year had made me quite familiar with the surrounding ranges, and this time I was able to work alone without a guide. My chief interest centered in the life-histories of amphibians, and, consequently, most of my time was spent outside. My excellent team of workers so well understood the indoor side of collecting that I had to put in only a few minutes a day looking over, measuring and cataloguing the mammals before or after skinning. The incoming reptiles and amphibians required more time, but long hours of work enabled me to devote an hour or two to them in addition to the eight or ten hours I spent collecting on suitable days.

CHILDREN AS COLLECTORS

Our relationship with the local children was amusing because so many of them developed into enthusiastic collectors, even the girls bringing in numbers of specimens. Yu-Fa's nephew, Ming Fa, though only twelve years old, proved to be the most skillful juvenile collector of all. He knew how to make snares and often brought in interesting species of rodents and other small animals. I seldom saw him empty-handed, and generally he looked like a moving rack hung with innumerable bamboo joints and other containers made of large leaves. The opening of these was exciting as well as dangerous because one never knew whether a pit-viper or a tiny frog would leap out. Ming Fa himself frequently forgot just what each held, so caution became our watchword when unloading his haul. We found it necessary to use great patience in explaining to those interested exactly what we were doing and what we wanted, and often, as a consequence, our orders were duly filled. We also found that, in following up reports of this or that rare creature, an equal amount of patience

had to be used. If careful cross-questioning did not arouse too much doubt, it was generally decided either to follow the informant or bid him fetch the specimen or specimens in question.

LARVÆ OF A PRIMITIVE SALAMANDER

On one occasion, my undue skepticism resulted in the loss of some exceedingly valuable material. A Kuatun hunter casually remarked that he had seen large clusters of amphibian eggs in a pool on the opposite range at considerable altitude. At the time, I was extremely pressed by a flood of incoming specimens and, consequently, refused to be led to the eggs described by him. Some ten days later, the rush had somewhat subsided and I bade the hunter show me his pool and eggs. He took me on a steep, three-hour climb to the very top of the opposite range and there, in a tiny trailside pool, we found a lot of recently hatched hynobiid larvæ, *Hynobius chinensis*. The hynobiid salamanders are a primitive group with extremely interesting breeding habits and I had planned to exert every effort to secure notes on their breeding. But my skepticism had prevented my coming until it was too late, and we could only return with some of the larvæ. The adults did not reveal themselves even though they must have been concealed underground among the roots of the dwarf bamboo growing profusely all around. The two small pools in which we found the larvæ held the only quiet water we could find for miles along the top of this range, so the task of locating the adults seemed impossible. In order to secure the adult stage, I was forced to surround one pool with a net and thus guard the larvæ against wild pigs for the remainder of the season. I had been warned that this pool was made by wild pigs and the larvæ would be killed by them if we allowed them to return and wallow in it. This warning was vindicated, for we discovered later that the larvæ were completely destroyed in the second and unprotected pool.

A SNAKE AS A COLLECTOR

On one of my visits to this breeding site, I had a unique experience, which proved that animals themselves can at times assist in the game of collecting. On this occasion, Yu-Fa and I were startled by a noise on the trail ahead. We hurried on, arriving just in time to see a large snake, *Elaphe carinata*, tumble off the narrow trail and slide down the mountainside below, a most unusual performance for a snake. It had evidently lost its hold. Following, we soon found it concealed among some rocks. It looked plump and we knew that it must have eaten a large meal recently. Pressure along its abdomen caused it to disgorge a living snake of a species new to our collection. We washed the victim in a near-by stream, and soon it was as lively as its captor and seemed none the worse for its drastic adventure. It is not

unusual to extract welcome specimens from preserved material, but one rarely is fortunate enough to secure a valuable addition to a collection in just this manner.

ADAPTATION OF FROGS TO CASCADING STREAMS

The presence of so many cascade-inhabiting frogs in the San Chiang-Kuatun region presented interesting problems in adaptation to a specialized environment. Life in rushing water has its difficulties for frogs as well as for other animals, and the sight of clear, cool water rushing over and among great boulders immediately makes one wonder just how each different kind of frog avoids having its eggs washed away and destroyed before they have had time to develop. Observations on species allied to various forms common about Kuatun have been made in other parts of eastern Asia, but, before 1926, little field work had ever been carried on in China, and I was especially anxious to get what data I could on all the local cascade inhabitants. One might expect frogs of the same genus to have similar breeding habits when living under the same conditions, but such did not prove to be the case. The eggs of *Rana spinosa* were easily found, while those of forms even more abundant almost entirely eluded us, so, obviously, the habits of *spinosa* are not like the habits of the other forms. *R. spinosa's* eggs are deposited in large masses securely attached to the lower surface of any submerged object. Each egg is protected by a double, transparent capsule of its own and attached by a stalk to the supporting object. The mucus which composes the stalk and capsule is not only tough and elastic, but readily adheres to either wood or stone. The resistance offered to rushing water by these securely anchored eggs is remarkable. In strong contrast to these eggs, the tadpoles that develop from them are not built to resist moving water but apparently must remain in relatively quiet pools, and protect themselves from currents by hiding among loose stones or in crevices on the bottom.

The tadpole of *Staurois ricketti*, another cascade frog, not satisfied merely to avoid currents, has developed perfect "stream lines" and a ventral sucking disc as well. I often saw *ricketti* larvæ feeding on convex surfaces of boulders in the face of strong currents. Unfortunately, I did not determine just where and how *ricketti* eggs were deposited, but almost certainly they are placed in relatively small and compact clusters strongly contrasting to the large, loose clusters made by *spinosa*.

It was the study and solution of problems such as those outlined and briefly discussed above that occupied most of my attention at Kuatun and San Chiang. Actual collecting of species was uninteresting by comparison. It was, of course, necessary to do much of this life-history work at night when frogs are most active.

SUMMARY OF KUATUN FAUNA

A prolonged study of our Kuatun collections has proved that we made no mistake in a choice of region. A brief summary should suffice to show the richness of the fauna secured there. In number of forms, the snakes come first with a total of thirty-five, and frogs second with twenty-four. The lizards are far behind with only nine, but these represent no less than six families, so there is enough variety in this group to make up for a deficiency in numbers. Turtles are conspicuously absent, while the two salamanders testify to the scarcity of this group also. I believe that turtles do not occur, because the Kuatunites were amazed at specimens that we had brought with us and unanimously declared such creatures to be non-existent in their region. This condition contrasts strongly with that prevalent in the mountains of Hainan where turtles are abundant. Making allowances for a few species that undoubtedly escaped us and still others that might accidentally reach the region, one may safely conclude that full eighty forms of reptile and amphibian life occur between San Chiang and Kuatun, the former at perhaps 3,500 feet, the latter at about 4,500 to 5,000 feet altitude.

FISH FAUNA OF CH'UNGAN HSIEN

The fish fauna of Ch'ungan Hsien proved to be interesting as well as rich. Mr. Nichols, 1931, has published a list of thirty-four forms making up the Ch'ungan Hsien collection. Twelve of these are known only from Fukien and adjacent parts of Kiangsi, while ten of these twelve have been described recently from the material of the Central Asiatic Expeditions. Those endemic to Ch'ungan Hsien, so far as known, comprise a peculiar, slender catfish with a forked caudal fin, *Leiocassis*, and a compressed, spine-cheeked loach, *Botia*. The third is a representative of the catfish genus *Liobagrus*, 1926, a genus varying little over its discontinuous range from the highlands of Yunnan to those of Formosa. The species, however, is distinct and is an addition to the Fukien fish fauna.

SMALL COLLECTION FROM HOK'OU, EASTERN KIANGSI

I originally planned to go on into Kiangsi from San Chiang, by way of Tungmukwan, and work the eastern part of that province, but, as time slipped by, there was more and more to do, and I finally decided to settle the matter by sending Da Da on a brief visit to Hok'ou. This plan turned out to be well worth while, because the small but rich collection of fish secured by Da Da proved to contain no less than six new forms, all of which have been described by Mr. Nichols. The reptiles and amphibians, although representing described species, have been of considerable interest for purposes of comparison.

CLOSE OF WORK IN FUKIEN

Fu Yu-Fa and many other local hunters insisted that if we could stay until October they would certainly add many new mammals to our already fine collection, but I had spent more than the allotted time in Fukien and had no choice but to return to Foochow. With genuine regret, we left our San Chiang and Kuatun friends on September fourth and reached Yenping the tenth, exactly seventeen months after our first arrival there in the spring of 1925. During these months, we had not only worked in crowded plains and valleys and wild, scarcely inhabited regions, but passed through "bandit" districts as well, yet scarcely once were we treated with anything but the utmost consideration and courtesy. If one can live in China through such disturbed and revolutionary times without experiencing even discourtesy, how much one may hope for when revolutions have ceased and normal times returned!

CHAPTER XLVIII

PALÆONTOLOGICAL EXPLORATION IN EASTERN SZECHWAN

WINTER SEASONS OF 1921–1922, 1922–1923 AND 1925–1926

BY WALTER GRANGER

MY ARRIVAL AT PEKING

I arrived in Peking as a member of the Central Asiatic Expeditions on June 28, 1921. This was almost at the beginning of our work in the orient. Doctor Andrews had reached Peking about two months ahead of me, and Clifford Pope, Assistant Zoölogist, came from America on the same boat with me. There was to be no Mongolian trip that year as the season was too far advanced, and immediately the question arose as to what I should devote myself between July, 1921, and the spring of 1922 when the actual start for the Gobi was to be made. We consulted almost immediately with our friends on the Geological Survey of China, Dr. V. K. Ting, the Director, and Dr. J. G. Andersson, the Mining Adviser. Their suggestion was that I, as the palæontologist of the Expeditions, should visit one or more of the fossil localities in central and southern China which had been brought to the attention of the Survey, but which for one reason or another the Survey had not been able to explore. The most promising of these seemed to be on the Yangtze River near Wanhsien in Szechwan.

FOSSILS REPORTED ON THE UPPER YANGTZE RIVER

A British Consul, Mr. J. Langford Smith, had resided at various stations along the upper Yangtze, and being an amateur palæontologist and geologist, he was interested in obtaining specimens and information relating to these subjects. One piece of information that had come to his attention was that of a deposit of fossil bones near the little village of Yen-ching-kou located about ten miles up the river from Wanhsien and ten miles inland on the south side. Fossils from this region were being brought to Wanhsien and distributed by the wholesale drug merchants, and Mr. Smith had seen and secured some of these bones at Chungking and other places. He had, in the

interest of science, communicated these facts to the Survey in Peking and they in turn generously passed them on to us. Those who have lived in China realize how difficult it is to obtain precise information about anything, but here appeared to be information that was definite, and so it was arranged that the exploration of the Yen-ching-kou region should be my first task.

SELECTING A FIELD STAFF

Being unfamiliar with the language and the ways of the country, it was important that I should have an interpreter and assistant for at least my first adventure inland. Doctor Andrews, in anticipation, had engaged a young Chinese named James Wong. Jim was an American-educated boy, having finished his schooling at the old Highland Military Academy in Massachusetts. He spoke English fluently, and his speech was adorned with American slang. He was alert, honest and conscientious, an excellent traveling and camping companion and he knew his own people well and had a most effective way with coolies. I met Wong, a day or two after my arrival, in the Rockefeller Medical School hospital. It seems that he had gone up to Manchuria on a short exploratory trip with Doctor Andersson while he was awaiting my arrival. While there he had a sudden attack of appendicitis, was rushed back to the newly opened hospital in Peking and there was used to christen one of the operating rooms. Following Wong's rapid recovery, came busy days of preparation for the winter's work in Szechwan. There was equipment to be carefully selected from the great supply which had been brought out from America, and a native personnel to be brought together. On trips to the interior, no matter how far one penetrates, it is best to take along from the start all of one's servants, with the exception of coolies; men who speak the same dialect, who understand one another's ways, and who work well together. Our party as finally selected consisted of seven. Besides Jim Wong and myself, there were Chow, Number One Boy; Yang, cook; Liu and Van, general assistants; and Chih, taxidermist. Of these servants, brought together for the first time, Chow remained as Number One Boy, serving both in China and Mongolia, until 1927. Liu became an expert fossil collector and preparator and remained until the close of the Expedition, as did Chih, who did taxidermy in the early days for the Expedition and later showed a fondness for the fossil work and developed exceptional skill at it.

PEKING TO HANKOW

On August 24, the party was ready to start with its thirty-one pieces of baggage, consisting of boxes of equipment and supplies, duffle bags and bundles of bedding and native clothing. The route was by rail to Hankow, thence by middle Yangtze River steamer to Ichang at the foot of the Gorges,

PLATE CXIII.

A. THE BUND AT ICHANG AT MEDIUM HIGH WATER.
A British gunboat in the foreground. Sept. 1, 1921.

B. SAMPANS ON THE YANGTZE RIVER.
Dr. Granger's party proceeding up river from Wanhsien to the landing at Pai shui chih

C. [illegible]ARCHED BRIDGE AT THE MOUTH OF PAI-SHUI-CHIH.
These lovely arched bridges are not uncommon in this part of China.

D. A CHARTERED CHINESE JUNK.
Dr. Granger's party proceeding down the Yangtze River to Ichang. March, 1923.

YEN-CHING-KOU.

Looking down the valley, toward the Yangtze, from near the base of the Dragon Bone ridge. The upper village and temple in the middle distance. In the foreground an inn known as the "White House." The white streak to the right of the paddy fields is the main trail between Hupeh Province and the river.

and from there by Upper River steamer to Wanhsien, well above the Gorges. The trip to Hankow was without accident but not altogether without incident as indeed few long rail journeys in China are. General Wu Pei-fu was carrying on warfare with the Szechwanese in the Yangtze Valley and the trains for Hankow were crowded with soldiers; so crowded, in fact, that in the dining car it was always necessary to clear the soldiers and their baggage from the tables before one could get a place to be served. In the middle of the night the car in which our boys were riding was detached from the train by soldiers, and our boys with the other third-class passengers were obliged to crowd into the observation section of the first-class car, in which Wong and I shared a compartment with a Chinese "General" and his aid. The next evening there was a threat to take our car off the train to use for the soldiers, and only the presence of the single foreigner in the car, supported by much argument with the station agent by Wong, prevented this happening. In 1921 the foreigner rated more in China than he does to-day.

ON BOARD THE "TUNG WO," A YANGTZE RIVER BOAT

Hankow was reached on the evening of the 26th, and the next boat to Ichang was scheduled for the 29th, which gave ample time for the purchase of our winter food supply, for making banking arrangements and for sightseeing. The Jardine Matthewson boat "Tung Wo," Captain Pellew, sailed at dusk on the 29th with our party aboard, and the change from the crowded, dirty and disorderly railway train to a clean, spacious, British-controlled river boat was a most agreeable one.

For some weeks the war clouds had been hanging low over the Middle Yangtze Valley. Chinese soldiers had been firing at the foreign steamers from the banks of the river and the situation was a bit tense. Steamers were making their trips between Hankow and Changsha and Hankow and Ichang with regularity, but the protection of British gunboats was occasionally needed, and all passenger boats plying the river were fitted out with thin steel plates which were placed along the rail outside the first-cabin quarters.

LOW-WATER AND HIGH-WATER LEVELS ON THE YANGTZE RIVER

The journey upstream from Hankow to Ichang when the river is still in flood occupies about three days. There are two regular stops, at the mouth of Tungting Lake and at Shasi, and if the visibility is not good at night the boat may have to drop anchor for a few hours while it is in the narrower and more tortuous stretches of the river. The Yangtze River is perhaps the most extraordinary river in the world in its annual rise and fall. Extreme high water, caused by rains and melting snows in western Szechwan and Tibet, comes in late July, and extreme low water about April first. Below

Tungting Lake the river widens out greatly and flows down to the sea in a bed often a mile or more in width, and the annual vertical rise of the water is not so great, but between Tungting Lake and Ichang the banks are often less than two hundred yards apart, and whenever the river reaches unusual heights it breaks through the dykes and floods great areas of the flat farming land, much of which lies below the level of the water in the river. Above Ichang, where the river emerges from the mountains of Szechwan and western Hupeh, the annual rise and fall is tremendous because the steep banks do not allow the water to expand horizontally. At Wanhsien, in 1921, the rise in July above the normal low winter level, which is called zero by river men, was 137 feet, and at the city of Wushan, which is located just at the entrance of the magnificent Wushan Gorge, there has been recorded a rise of 200 feet. Passing by on the river in early spring the stranger looks at these gorge cities perched high up on the hillside and wonders why they were built so far above the water, but passing by again in midsummer he finds that the river has risen to meet the city and usually to even submerge the lower part of it.

We found, in late August, much of the land along the river between Tungting Lake and Ichang under water. On the south side where dykes had broken in many places, the water extended as far as one could see—probably seven or eight miles and all that was left above the surface were numerous little islands of high land on which groups of farm buildings or small villages with their accompanying trees were perched. The Chinese have a wonderful faculty for carrying on their daily affairs in the midst of adversity and this was well illustrated here. With all their belongings, buildings, live stock and crops huddled together on a tiny patch of ground entirely surrounded by the muddy waters of the Yangtze, the families were busily engaged in threshing on the tiny threshing floors in front of their houses such grain as they had been able to salvage before their fields were flooded. Often these islets were within hailing distance of our boat as we churned our way up the main channel between the dykes, and from the upper deck of the boat we looked out over the top of the dykes at the fascinating but distressful scene. A few hours below Ichang, low hills begin to come in sight, increasing in height as one approaches the city, and it was a relief to find the river again confined within its banks and the farms and villages undisturbed. In 1930 there was almost unprecedented high water in the Yangtze, and the whole valley below Ichang to the sea was flooded to a depth which wiped out the farms and villages and produced one of the world's great calamities.

INTER-PROVINCIAL WARFARE ALONG THE YANGTZE

In considering the Wanhsien locality for exploration, we had before my departure from Peking talked over very carefully the chances of my running

into active inter-provincial warfare along the Yangtze which might seriously interfere with our progress up the river. After consultation with Doctor Coltman, of the Standard Oil Company, and one or two other men who knew their China well, it was decided to take a chance, trusting that either the trouble would not assume dangerous proportions or that we might slip through before things broke. The mere movement of soldiers and the occasional firing on river steamers were not sufficient to stop us. That sort of thing had been going on for ten years—ever since the establishment of the Republic—and was one of the hazards which any up-river traveler expected to take. We had encountered soldier movement on the train to Hankow and in Hankow itself, and the steamers were being shot at rather regularly, but still things seemed more or less normal, and we had begun to feel that we should reach Wanhsien without unusual incident. No sooner, however, had we dropped anchor off Ichang at 7 P. M., September 1, than we found that we had been running directly into one of the liveliest fights of the year. The Szechwanese had for some time been coveting the control of Ichang which is in the Province of Hupeh. The city is situated below the Yangtze Gorges, and quite different types of boats are used on the river above this point—junks and steamers especially built to take the swift waters of the rapids. All cargo is, therefore, trans-shipped at Ichang, and this gives a splendid control over river traffic and a wonderful opportunity for all sorts of taxation, legal and otherwise. Reason enough why Ichang should be coveted by the Szechwanese.

We were told by residents who boarded our boat immediately we came to anchor, that for some days the Szechwan soldiers had been coming down through the Gorges in junks and massing just above the town. An assault upon the city was promised at almost any time. Two American, two British, and one Japanese gunboat were anchored near-by in the river. As usual at Ichang, we were permitted to use our steamer as a hotel, since there was no suitable accommodation ashore. My up-river steamer, the "Lung Mow," had not arrived from Chungking, and so we looked forward to an interesting time—an opportunity to watch, under the protection of our own gunboats, the sort of warfare which had kept China in turmoil for ten years.

Actual fighting broke out the next afternoon as we were taking our heavy luggage ashore to a warehouse. It was three or four miles upstream but could be heard plainly and the shelters of the defending troops could be seen with field-glasses. While ashore I took the occasion to call upon H. B. M. Consul Langford Smith, to whom we were indebted for the information which was taking us to Wanhsien. I found the Consul extremely busy and rather excited over the local war. He was offering the protection of the Consulate to the resident British women and was himself about to go aboard one of the British gunboats to be taken up to Kueifu, above the Gorges, for a conference with

the Commander of the Szechwan troops in an effort to save Ichang from assault and subsequent looting. He kindly invited me to examine, during his absence, the small collection of fossils which he had accumulated while stationed along the Upper River. I found the next day when I again visited the Consulate, a few fragmentary bones from the Yen-ching-kou field and recognized among these the broken limb bones of a proboscidean (*Stegodon*) and of a rhinoceros. It was most encouraging to see these specimens, because to me they were evidence that we were not on a false trail.

On the following day, September 2, the fighting came closer, and there was considerable excitement among the native population and much activity among the military. *Lafu*, or coolie drafting, was being conducted in the streets, and groups of the poor devils tied together by strings about the arms were constantly being driven along the Bund. In all Chinese armies drafted coolies are used to carry the supplies, equipment and ammunition for the soldiers. They are taken wherever they are found by the soldiers detailed for that purpose, in the streets, in shops or in their houses. They are paid nothing, fed very little, and in times of stress are frequently worked to death, or accidentally killed on the firing line. Executions were taking place in different parts of the city. One poor sampan coolie who had remonstrated mildly with one group of soldiers, that had commandeered his sampan, lost his head on the Bund directly opposite our steamer. Toward evening the fighting on the opposite side of the river came closer, as the defenders retreated toward the city, and on the following day it came still nearer, so close, in fact, that we could now watch much of the fighting with glasses from the deck of the boat. Villages on both sides of the river were being deserted by the residents as the Szechwanese closed in. The river was dotted all day long with small boats heavily loaded with peasant families and such of their more precious belongings as they could hastily gather together and take downstream to a place of comparative safety.

On Sunday, the fourth, the Szechwanese, who had now been reinforced by arrivals from up river, made a grand assault on the defenses along the river directly opposite Ichang and carried them. The Yangtze at this point is over half a mile wide in September, and the shore on the opposite bank rises very abruptly to a series of pinnacles and crests five hundred feet above the water. Most of this slope is so steep that it can be climbed only with difficulty, and in places there are vertical cliffs. The assault began a little after daybreak and from the vantage point of our steamer deck we watched the entire attack. The defenders who had been holding this ridge opposite Ichang were driven off it before our eyes. Some of them managed to get into ravines between the pinnacles and reach the water's edge by steep trails, but many were actually pushed over the sheer face of the slope and rolled down

PLATE CXV.

A. YEN-CHING-KOU.

The main highway through the lower village. The Dragon Bone ridge is seen in the background.

B. THE 1922-1923 PARTY IN THE TEMPLE AT YEN-CHING-KOU.

Foreground -Granger, Wong. Middle row, left to right, Chow, Number One Boy; Kan (Buckshot), chief technical assistant; Chih, taxidermist; Whey, cook. In the background two local coolies, put in uniform to insure against drafting by the soldiery.

THE UPPER VILLAGE OF YEN-CHING-KOU WITH THE TEMPLE IN WHICH THE PARTY LIVED DURING THREE WINTERS.

to the water's edge, either killed by the fall or drowned as they plunged into the river. The various boats which the defenders had tied up along the banks in case of retreat were hastily filled by those fortunate enough to reach the river bank alive, and the boats were started across the stream to the city. These made wonderful targets for the Szechwan soldiers, who now lined the crest, and there were many casualties before the boats reached the Ichang shore. Many defending soldiers reached the water's edge from the crest above to find no boat for them and so plunged into the river and attempted to swim downstream to safety. Some were shot as they drifted downstream, but the river itself claimed most of them, for the current is an extremely treacherous one. Apparently only a very few soldiers who tried this means of escape actually reached safety.

During all this fighting the bullets were flying over the boats anchored off the Bund. Some of them fell too close to us for comfort, and one or two Chinese members of the gunboat crew near us were hit. Still it was an interesting spectacle, and even the old China hands of Ichang came down to the Bund to watch. I remember observing the first onslaught through my porthole while shaving shortly after daybreak, and the observations were continued through the saloon windows while at breakfast and later from the upper deck of the steamboat. By nine o'clock the firing had ceased and there was no more fighting until we left three days later. Eventually the Szechwanese crossed the river above town and made a direct assault on the city, but were driven off at the last moment just as they were about to scale the walls of the old town, by the timely arrival from Hankow of General Wu Pei-fu and a few hundred of his picked soldiers. The city had been almost in their grasp but they were obliged to retire and return to their own province without the prize.

ON BOARD THE "LUNG MOW" AT ICHANG

The "Lung Mow," Captain Hall, arrived from Chungking on September 4, and I immediately went aboard with my party and duffle and on the seventh at daybreak we began the long day's journey through the wonderful Yangtze Gorges, arriving at Kueifu just above the uppermost Gorge at dusk.

THROUGH THE YANGTZE GORGES, ICHANG TO WANHSIEN

The trip up the Yangtze Gorges was an exciting journey in more ways than one. The scenery is sufficient to cause a thrill the first time one sees it, but we had added to that the thrill of being shot at frequently. The Szechwan soldiers were still coming down river in great numbers, and we met junk-loads of them every half-hour. It so happens that junkmen on the upper river have a hearty dislike for the steamers. This is partly because the steamers

are rapidly taking their trade away from them and partly because in going upstream the larger steamers create a swell which is not only unpleasant but often decidedly dangerous to the junks; occasionally one is capsized, and a large boat like ours was in bad odor with the river men. This dislike on the part of the junkmen was shared by the soldiers, and whenever one of the junks dropped astern of us and caught our toppling swell it irritated them to the point of firing a few shots at us. After one of their bullets had come aboard and crashed into the dining saloon, narrowly missing a group of us sitting on the rear deck, the captain blew his whistle whenever he saw a junk-load of soldiers approaching, and the first officer drove all first-class passengers below to the protection of the steel hull of the boat. This interfered with our view of the Gorges but there was no help for it.

At Kueifu we found that we were under the ban of the military, who presumably had been informed by wire of the commotion we had created during the day among the soldier-laden junks in the Gorges. At any rate no sampans were permitted to put off to our steamer. However, a British gun-boat anchored near-by sent a small boat over to us and in that way we learned about local affairs and the progress of the campaign against Ichang. Upper river boats, both junks and steamers, never travel at night; the river is too narrow, the current too treacherous and there are too many submerged rocks to make navigation possible except in broad daylight. Even then it requires all the skill of the experienced Chinese pilots to navigate this most dangerous stretch of water. The wrecking of junks is almost a daily occurrence, and the toll taken by the river in a decade is tremendous. So we remained at Kueifu over night in grand isolation and early the next morning were off again—out of the Gorges now, but still in rough country with precipitous hills on either side of the river. At noon we anchored opposite Wanhsien and our journey from Peking was ended.

AT WANHSIEN

Two maritime customs tide-waiters, Messrs. Fuller and Jenkins, came aboard and extended to me the cordial invitation of their chief, Acting Deputy Commissioner C. G. Asker, to make my headquarters at his home.

The Maritime Customs at Wanhsien were housed in a large temple on a cliff overlooking the river on the outskirts of the town. Here were the offices as well as the living quarters of the Acting Commissioner and his outdoor staff. The temple, through the friendly courtesy of Mr. Asker, became the Expedition headquarters for the next seven months. A large room was put at our disposal, and Wong and I were welcome guests at Asker's table whenever we were in town. This to me, on my first trip to the interior, was an all-important consideration. A safe and comfortable headquarters,

with the advice, assistance and protection of a Government official of high prestige in the community, was a thing to be desired and it did much to make my first season's work pleasant and successful.

Wanhsien, numbering about 50,000 people, is on the north bank of the Yangtze about half-way between Ichang and Chungking and is the largest city in this stretch of the river. There is a handful of foreigners distributed among the Hai Kwan (Customs), the Post Office, the two Missions, the Standard Oil installation and the two or three import and export houses—enough to maintain a tennis court and to give a table or two of bridge. The town is unspeakably filthy and is the center of most of the political intrigue of eastern Szechwan. It is usually the headquarters of one of the many Provincial military units and has been the scene of much fighting. In the summer the river rises and floods the lower part of the town, including the main business street, and new business centers have to be established higher up. In the winter the river lies at the foot of the city and is reached by several broad stone stairways leading down from the main street. On the wide foreshore of sand and shingle bank a new town arises early each winter as the water recedes. Temporary structures of thatched paneling are set up, streets established and a thriving business carried on with the river men until the next spring, when everything is moved to the higher slopes again. This condition is typical of all towns along this stretch of the river where the great annual rise and fall of the water occur.

The few days following our arrival in Wanhsien were active ones. There were the Magistrate and the Military Commandant to be called upon (for which visits I was loaned the official Customs carrying-chair); arrangements had to be made with the Standard Oil manager to obtain Szechwan silver dollars for my Hankow checks; the two Missions were visited and additional supplies and equipment purchased.

FOSSIL BONES AND THEIR USES

The day after we reached Wanhsien, one of the local wholesale drug merchants from the opposite end of the city came to our headquarters. He had heard of my mission, for news travels faster in China than almost anywhere else, and had brought along with him a sack full of fossils from the very locality we had come to explore. His name was Chang and he told me that he made two or three trips every year to Yen-ching-kou to purchase fossil bones as a part of his stock in trade.

I might say here that for generations vertebrate fossils, known to the Chinese as Dragon Bones and Dragon Teeth (Lung Ku and Lung Ya), have been articles of the Chinese pharmacopœia. They are prescribed by Chinese physicians of the old school for all sorts of complaints, ranging from headache

to Bright's disease, and are usually taken in powdered form, although sometimes the fossils are soaked in alcohol and then the alcohol is drunk, or fried in grease and the grease eaten, it presumably having absorbed the virtue of the dragon's bone. It is interesting to note that the first real information palæontologists had of the fossil mammalian faunas of China was from a large collection of fossils purchased by a German doctor, named Harberer, in numerous pharmacies throughout China. The druggists from whom the bones were bought could not or would not give information about the source of these things, but from bits of matrix still adhering to some of the fossils and from the fossils themselves, Dr. Max Schlosser of Munich, who made the study, was able to classify the specimens in a fairly satisfactory way and to draw the first adequate picture of the mammalian life of the region during late Cenozoic time.

When Chang opened his sack and we found inside many beautifully preserved teeth of rhinoceroses, *Stegodon*, and other animals, we knew even better than at Ichang that we were on the track of a real fossil deposit. Chang, with his apprentice, was immediately engaged to go with us to Yen-ching-kou, as soon as we were ready, to act as guide and as intermediary between ourselves and the men who were doing the excavating.

A TRIP TO YEN-CHING-KOU, A FOSSIL LOCALITY

Yen-ching-kou is on the opposite side of the river from Wanhsien and is reached by going ten miles up the river by sampan and then either by foot or by carrying-chair ten miles inland from the south bank. It was my desire before getting so far out of touch with Wanhsien to make a camp near-by in order to try out our equipment and our personnel. I wanted to make such changes as had to be made before we settled down for the winter. Mr. Darlington of the China Inland Mission made it easy for me to carry out this plan. The summer quarters of his mission, Luan-shih-kao, was located about twenty miles north of Wanhsien on a ridge 3000 feet above the Yangtze and within a half day from Wanhsien by runner, and he offered me the use of this place for as long as I cared to stay. There were no fossils at Luan-shih-kao, but I planned to utilize the time by collecting birds and mammals. On September 13, we went to Luan-shih-kao, took up quarters in one of the Mission buildings and returned to Wanhsien on September 27. We came back with a few mammal skins, jars of reptiles and batrachians in formalin and an interesting lot of birds; also our servants, after some little persuasion on Mr. Wong's part, had become adjusted to one another and to us, and the party seemed to be in good working order.

Our real task now lay before us, and on October 2 I sent Mr. Wong off with the camp equipment, two of our servants and Chang, the drug merchant,

and his apprentice. Wong was to go to Yen-ching-kou, locate living-quarters, get in touch with the dragon-bone diggers and send back word when all was ready. Two days later the apprentice returned with a letter from Wong, reporting that all was well, and on the sixth, with the Number One Boy, the cook, and with the apprentice as guide, I set out. It was always a long day's journey to Yen-ching-kou from Wanhsien, upstream on the river and uphill on the land. Leaving Wanhsien about 8: 30 in a large sampan manned by a crew of three or four, we rowed, poled and tracked the ten miles to the foot of the Fu Tan, one of the bad rapids of the river at medium high water. We crept up along the north bank until within sight of the Fu Tan, then we crossed the river, losing perhaps a half mile in the passage through the swift water, and then poled up to our landing along the south bank. At the foot of the Fu Tan on the south bank, a fair-sized creek called Pai-shui-chih (White Water Creek) empties into the Yangtze, flowing down into the big river in white foam over a broad shelving rock, with one of the beautiful Szechwan stone arch bridges silhouetted against the sky at the head of the falls. At Pai-shui-chih landing we left the sampan and engaged carrying-coolies for the ten-mile journey up the creek to Yen-ching-kou which we reached about dark. I made this journey many times subsequently and the procedure was always about the same; any variation from the routine usually occurred at the landing and had to do with carrying-coolies. Ordinarily, we had no difficulty in hiring the few men necessary for our baggage, but in times of military activity we would find no coolies in sight, and on occasions we had to appeal to the local official who would send into the village and rout out the coolies from their hiding places and draft them into our service. This would sometimes delay us for several hours and bring us to Yen-ching-kou long after dark.

On this first trip Wong had sent coolies down to the landing to meet us and we were soon on our way up the valley, traveling the stone-paved path which is one of the main highways between western Hupeh and the Yangtze. In eastern Szechwan, which is extremely rough and mountainous, there are no wheeled conveyances and but very few beasts of burden such as the small riding-ponies and these are usually in the possession of military officers. Practically everything is carried on the backs of men, and the roads are merely pathways just wide enough to permit two carrying-coolies to pass each other by a slight adjustment of their loads. There is very little flat ground, and the paths pass up over the sharp ridges and down across the narrow valleys with little or no attempt at grades, and along the ridges the pathway becomes merely a series of stone stairs. It is most fatiguing travel, and most foreigners, and the Chinese who can afford it, ride in carrying-chairs and let the coolies take the fatigue.

LIVING QUARTERS AT YEN-CHING-KOU

Yen-ching-kou comprises two tiny hamlets perhaps 200 yards apart, situated in a stream valley. Each consists of a row of low buildings on either side of the main trail, mostly squalid homes but with an inn in each village and an opium-smoking den in the lower one. The lower village also boasted two wood oil pressing establishments. In the upper village, however, was a temple or rather an Ancestral Hall which dominated everything, and here shortly before dark our little procession came to a halt and Mr. Wong ushered us into what was to be our home for the next five months.

Foreigners who travel inland in China, especially if they have their own servants, camping equipment and supplies, find the temples the best stopping-places. Public inns abound, but they are usually noisy, dirty and infested with vermin. The temples, on the other hand, afford quiet and relative cleanliness, and the caretakers are almost always willing to afford accommodations for a small fee. One's cot and folding table can be set up in front of the idol platform; water and fuel are brought in by the temple coolie; one's boy prepares the meals in the temple kitchen, and the curious villagers can be kept out by closing the front door.

Wong, upon arrival at Yen-ching-kou, had realized that this Ancestral Hall of the T'an family was the only suitable place for us and he had gone to the family elders and obtained permission for us to take it over and had arranged for the rental which was to be $3.00 Mex. per month—about $1.50 American currency! The various farm products and implements which had been stacked in the court were removed and the place swept out and made thoroughly habitable. Nothing remained but several large wooden coffins which belonged to various elder members of the family and were being stored in the temple until such time as their owners should need them.

An Ancestral Hall is built on almost exactly the same lines as a Buddhist temple. The chief difference is that the idols of the temple are replaced by ancestral tablets, slabs of stone inscribed to the glory of the departed ancestors. Our Hall belonged to the family of T'an—the dominant family in that neighborhood. It was not a large building but adequate for our purpose. There was an open court bordered on two sides by long narrow galleries at right angles to the street; on the side toward the street the gallery was considerably widened by extending it into the court. This is known as the stage of the temple, and on the fourth side, directly across the court from the stage and at a lower level, was the shrine platform, or chancel, at the back of which, on a sort of long altar-like structure, were placed the three ancestral tablets. An ell built onto the main structure housed the temple kitchen where feasts were prepared on special occasions and on either side of the shrine platform were small rather dark rooms, one of which we used as a kitchen and the other

was appropriated by Chow. The rest of our boys slept on one of the long galleries; Wong and I used the stage, and the other long gallery was used for a workshop and for the storage of specimens.

The only drawback to this temple as a residence, and we lived there for three full winters, was that there was no entirely enclosed room which could be heated, and the winter climate at Yen-ching-kou, which is 1,000 feet above the Yangtze, is always damp and the temperature occasionally is below the freezing point. Such warmth as we had was obtained from fire baskets or by visits to the partly enclosed kitchen where the cook had a sheet-iron stove.

Our occupancy of the temple did not in any way prevent the members of the family from carrying on any of their regular ceremonies. Every night and every morning the caretaker, who lived next door, came in and did the routine temple service of pounding a drum, tapping a bell, putting lighted incense sticks in various places and kowtowing three times in front of the tablets. This ceremony was never omitted and never varied except at Chinese New Year when ceremonial candles were lighted, an oil wick was kept burning all night and firecrackers and bombs were set off in the court. During this one great holiday period of the year, all members of the family came at one time or another to the temple and paid their respects to their ancestors in the usual manner of bowing three times before the tablets and leaving incense sticks or candles on the altar. On two occasions the family elders held, in front of the tablets, trials of certain members of the family guilty of serious offenses. The front door was usually left open during the daytime and the villagers and passers-by swarmed into the court below, but only the family elders or those especially invited ever ventured up to our gallery.

THE MODE OF OCCURRENCE OF FOSSILS AT YEN-CHING-KOU

Wong had not told me in his letter about the mode of occurrence of the fossils at Yen-ching-kou, and on the way up from the river I kept a sharp lookout for places in which Pleistocene fossils might be expected, but there was not, so far as I could see, the slightest suggestion of such a place. The formation throughout was the Permo-Mesozoic red clays and buff sandstones and there was no accumulation of later deposits, just a rough terrain of highly eroded, rather ancient sediments—the last place in the world to look for Pleistocene fossils. Arriving at Yen-ching-kou, I found the village nestled at the base of a great ridge of Palæozoic limestone which had been thrust up in remote times through the Permo-Mesozoic red beds. The ridge rose abruptly nearly 2,000 feet above the valley and was nearly fifty miles long. It was the conspicuous feature of the landscape as one looked south from the Yangtze River which parallels the ridge ten miles away. I could still see no chance for

Pleistocene deposits, in fact, the problem became more perplexing than ever to me.

Almost the first question I asked Wong upon greeting him was where the fossils came from, and when he told me that they came from the top of the big ridge I was completely bewildered. The following day found me on the ridge early to solve the problem which had been perplexing me since we saw the first bones in Ichang. This is what I found:

Limestone is mildly soluble in rain water, especially water which has soaked through humus and decaying vegetation. Such water gathering in pools on top of the limestone ridge had in times past, when the region was forested, dissolved out shafts in the rock—sometimes to a depth of one hundred feet—often to fifty feet or more. The soluble parts of rock passed on down through cracks and the residue remained as mud in the bottom of the pit. These shafts were really vertical caves, and the action which produced them was similar to that which produces horizontal caves.

The majority of the shafts or pits seem to have been of Pliocene or early Pleistocene origin, and they are for the most part filled to-day with yellowish or reddish mud which had flowed in from the surface or had been left as undissolved residue. There were times, however, when they were open and evidently acted as pitfalls for the various animals which inhabited the region. At any rate the fossil bones were being found in the mud filling of the pits—and usually at depths of twenty feet or more. It was quite evident that the bones got into the pits in two ways. When a complete skeleton was found in a pit it seemed almost certain that the animal had fallen in and either had been killed by the fall or had died of starvation. On the other hand, when single elephant teeth, sometimes considerably weathered, were found, it seemed obvious that the animal had died on the surface, its skeleton had become disorganized and parts of it had gradually drifted into the pit by gravitation.

A few such pits as these are being formed to-day along the top of the ridge, and undoubtedly they still occasionally act as traps for unwary animals that stray too close to the edge, which is usually masked by a dense undergrowth. Some of these open pits have diameters of fifty feet or more—real sink-holes—but more often they are smaller—eight or ten feet across. The pits as observed are rather unevenly distributed along the fifty miles of ridge top, although this may be simply because certain areas are more denuded than others and the pits consequently are more easily located.

Just how the Chinese discovered that there were "dragon bones" deep down in the pits I do not know. The story told me, and which might easily be true, was that some farmer attempted to dig a well in one of the pits and ran onto the bones which were too deep down to be mistaken as burials of

modern animals; moreover, what was more important, they responded to the test for real dragon bones, that of adhering to the tongue. I was told that the discovery dated back at least two generations, and I judge from the number of old worked pits that this is probably true.

The top of the Dragon Bone ridge is very uneven—a series of large, rounded sugar-loaf hills with broad open valleys between. The highest knolls rise at least 500 feet above the low depressions. There is no real drainage, each little valley being an independent drainage system by itself. Rain water flows to the lowest part of the depression, disappears in a sink-hole and apparently comes out as springs at the base of the ridge. There is considerable soil in the lower areas, and farmhouses are found at frequent intervals along the entire ridge. I do not think that the topography of the ridge top has altered much since Pleistocene times, although portions of it must have been heavily forested then.

CHINESE METHODS OF COLLECTING FOSSILS

In the autumn, after the crops are gathered and the winter planting done, the men from neighboring farms gather into a working party, obtain a grub-stake from one of the wholesale drug merchants along the river and set out to locate pits. Sometimes pits are located and worked to a depth of fifteen or twenty feet and then found to pinch out and to contain no bones. Many such blanks may be drawn in one season. One good pit, however, yielding several hundred pounds of bones, will probably pay modestly for the winter's work and occasionally a large and very deep pit is discovered which will yield a ton or more of bones and become a bonanza to the discoverers.

A crude pulley on a horizontal bar is erected directly over the pit after it is located and its surface outlines determined, and the work begins. One or two men down in the pit dig up the mud with an adze-like tool and it is pulled to the surface in scoop-shaped wicker baskets by means of a bamboo rope passing over the pulley. At least two men are on the surface to pull the baskets up, and whenever bones are encountered the mud is scraped off and they are set aside to be taken to the farmhouse of a member of the group at night. Here they are spread out in any available place to dry. After the pit is exhausted the party waits for a bright day and holds a cleaning bee. Each bone, now well dried, is scraped clean of dirt and put in a great pile in the corner of the home, or put into huge baskets, and then the product is ready for the buyers who travel along the ridge several times each winter season. The price paid at the time of my visit for dry, well-cleaned bone with a fair amount of teeth mixed in was the equivalent of about six or seven cents per pound.

OUR METHODS OF COLLECTING

My method of obtaining specimens from this region was not to work pits ourselves, which could not have been done without exciting much suspicion and opposition, but to locate all of the producing pits within reach and to make frequent visits there, then to watch the bones as they were brought to the surface and make our purchases on the spot. Each handling by the digger was apt to do some damage to the specimens, especially the more delicate skulls, and I particularly desired to get them before the final cleaning process, which was severe treatment to a scientific specimen. To the diggers, of course, a gin of dragon bones was a gin of dragon bones, and it didn't detract from the value of a fine skull to have a few teeth knocked out of it so long as the loose teeth were there to weigh in when the bones were sold. But to a palæontologist, with a reverence for fine specimens, such treatment was a horrible sacrilege. Sometimes we would not hear of a pit until the work had been finished and the bones obtained from it either cleaned and stacked up or laid out for drying. All available places in the farmhouses were used for the drying, and I still have to smile when I think of my going into these dark, dingy houses, flashlight in hand, and rooting about in attics, under beds and in all sorts of dark corners, in my search for desirable specimens; it was the most extraordinary collecting I have ever done in my thirty-five years of experience.

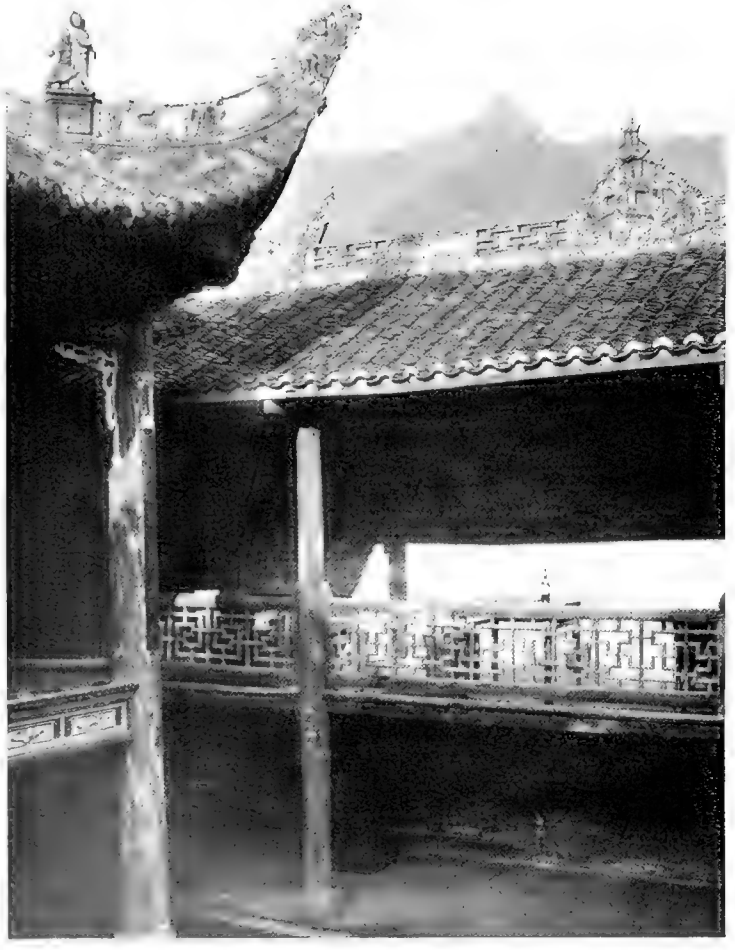
I do not know whether the diggers understood, even with Wong's explanations, just what I wanted the bones for, but they did understand that I paid as much per gin (one and one-third pounds) for heavy wet bones just up from the pit as the drug merchant paid for dry cleaned bones, and this they appreciated. Also they learned after a while that I would pay a bonus for skulls if they were taken out with special care, and toward the close of the first season and during the subsequent seasons many fine skulls were brought to us at the temple or held for us until we passed along the ridge on one of our periodic trips.

PLIOCENE AND PLEISTOCENE FAUNAS

The fauna obtained from the pits comprises some twenty-five genera of mammals and apparently belongs to the earliest Pleistocene period, although there are present two or three distinctive Pliocene forms which seem to appear here as holdovers.

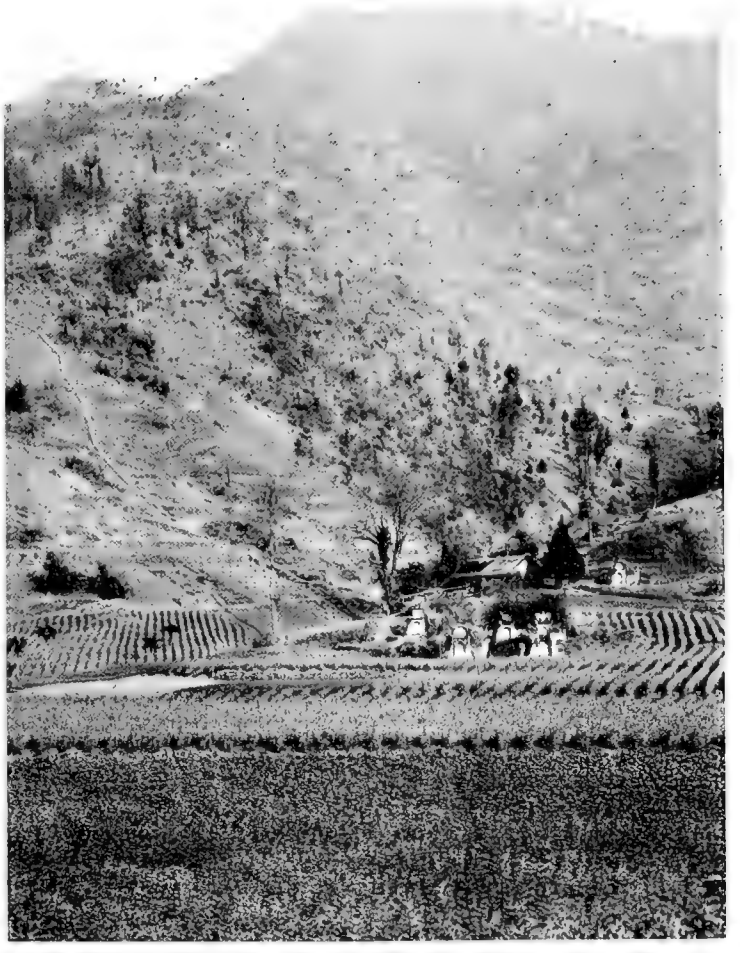
The largest and most conspicuous of the animals is the extinct proboscidean known as *Stegodon*, a common form in the Siwalik Hills of India where it is found in beds of definite Pliocene age. *Stegodon*, in its tooth structure, is midway between the mastodons and the elephants. Next in size to the *Stegodon* is a rhinoceros closely allied to the great one-horned Indian rhinoc-

PLATE CXVII.



A. TEA-HOUSE AT YEN-CHING-KOU.

Showing the residence, gallery and a corner of the stage and sections of the ornate roofs.



B. CULTIVATED FIELDS AT THE BASE OF THE DRAGON BONE RIDGE.

At the left are the stone steps up which the 1,700 foot climb to the fossil pits was usually made.

A. THE TEMPLE AT MEN-CHING-K

B. A PIT IN THE MIDDLE OF A CULTIVATED FIELD ON THE DRAGON BONE RIDGE.

The excavation of this particular pit yielded no fossils—one of the numerous blanks which the excavators draw.

eros of to-day. Then there is the great gaur, the largest of the Asiatic bovids; a giant tapir of a new genus, *Megatapirus;* a large cat, hardly distinguishable from the tiger, as well as two or three smaller forms. That extraordinary family of clawed ungulates, now extinct, known as the chalicotheres, is represented in the collection by a single tooth. The rare and peculiar pseudo-bear, called the giant panda, which lives to-day in western Szechwan, is represented by a fossil form, and there is also a true bear of an extinct species. The balance of the fauna includes deer of several species, goats, hyænas, dogs and small carnivorous animals of different sorts, a bamboo rat in great abundance, a monkey, and one anthropoid ape—the gibbon.

It was interesting to note that the pits in the lower areas contained animals not frequently found in pits high up on the knolls. *Stegodon*, *Rhinoceros*, the giant tapir and the gaur were, as might be expected, confined pretty much to the lower pits, while the deer and goats were found more abundantly in the pits higher up. One would naturally expect large animals to keep more or less to the lower levels, while the deer and goats would frequent the hills.

Of the animals living on the ridge during early Pleistocene times, some forms, such as *Stegodon* and the chalicothere, are now extinct. Others, such as the tapir, rhinoceros, hyæna and gaur, are still living as closely related species but in regions remote from Szechwan. A third group, including some of the deer, goats, smaller carnivores and the rest, are to be found living in the immediate region to-day, but they are of species distinct from the animals of the pits, although closely related.

EVIDENCE OF CONTEMPORARY HUMAN OCCUPATION

A keen lookout was kept for any trace of contemporary humans in the pits, but only two rather unsatisfactory bits of evidence came to light during our work. At one farmhouse on the ridge, where there was an accumulation of many hundred pounds of fossils which came from a single pit near-by, the farmer brought out a small perforated disk of stone about the size and shape of an ordinary checker. It was undoubtedly of human origin and was well encrusted with a calcareous deposit. This man, who had had charge of the excavation, informed me that it came from this particular pit, which had yielded, among other things, an abundance of *Stegodon*, and was found at a depth of twenty feet or more. The stone undoubtedly has considerable age, but it is unreasonable to expect such a finished artifact to come from an early Pleistocene deposit. If it actually came from the pit as the farmer declared, and as the encrusting would indicate, it was probably deposited later than the *Stegodons*, hyænas and other associated animals.

The second bit of evidence was that presented by a deer antler, some of

the prongs of which had been cut off with the aid of a crude implement. The antler was a true fossil, in exactly the same state of preservation as all others from the pits, and the cutting was ancient—probably done while the antler was fresh—but there is a question as to just where the antler was found. The incisions were not noticed in the field, and it was not until the specimen was cleaned in the laboratory that anything unusual was observed about it, and unfortunately this was one of the few specimens that arrived without full data. A small collection of bones, including an antler or two, was purchased in Wanhsien of our wholesale drug merchant the day before our departure on our return journey to Peking. They were said to have come not from the Yen-ching-kou region but from caves or pits in northwestern Hupeh. It is quite possible that this particular specimen was one of this lot which in the hurry of departure did not receive proper labeling. Here again, while there is unmistakable evidence of the early occupation of this region by man, we cannot assume that he was living there as a contemporary of the Yen-ching-kou fauna. Mr. N. C. Nelson, archæologist of the Expedition, visited Yen-ching-kou in the spring of 1926, examined a few working pits and looked carefully over the dumps of many dozens of old pits, but never found a trace of stone implement or a chip from the manufacture of an implement. It is true that no stone suitable for working occurs in the region of the fossil ridge, but such stone is to be found in the shingle banks of the Yangtze ten miles away, and it seems reasonable to assume that, if man had been living on the ridge while the bones were being deposited in the pits, some definite evidence of his occupation would be presented in the hundred or more pits which were examined. Nelson found a late Neolithic culture along the Yangtze, but there is no evidence that these people, who used the material of the shingle banks for making their implements, strayed very far from the river banks.

OTHER FOSSIL LOCALITIES NEAR YEN-CHING-KOU

Several times during the winter I took long trips southward on the Dragon Bone ridge, trips lasting four or five days and taking us forty or fifty miles away from Yen-ching-kou and to the farthest pits of which we had any knowledge. These trips were always of unusual interest to me because they took me to regions where no foreigner had been before. Even on the main highway, which passed through Yen-ching-kou, not a single foreigner traveled through, during the three winters I was there, and I could learn of only two white people (missionary women) who had even been through the village. Over the rough trail along the top of the ridge no foreigner had ever traveled before.

Wong usually went with me on these trips and we took along our boy Chow as personal servant, and enough coolies to carry our loads. I always

walked, but Wong, who was not physically strong, had a chair, and we usually permitted Chow to have a small two-coolie chair because at the end of the long day's tramp when I would arrive at the camping place pretty well fatigued and ready for rest, Chow's work was just beginning and it was important that he should arrive in camp fresh and able to attend to his duties. There are few temples along the ridge and so we always stopped at farmhouses. Frequently the farmers were timid about taking our party in, but Wong's persuasiveness always overcame any objections they may have had.

In the larger farms the house is usually built in a ⊔-shape, partially enclosing a court. In the center of these structures there is always a clean, dry room set aside as a shrine room, where the little morning and evening religious ceremony is performed and where an occasional wedding takes place. This was the room always allotted to me, and here Chow would set up our cots and place a table and chairs and make us very comfortable. Being a guest, I could not, however, expect the privacy of our temple, and as a foreigner was a decided novelty in these parts, I had to submit to inspection by the entire family and such of the neighbors as ventured in. Frequently when Wong was not with me, I ate my dinner by candlelight at night with an audience of twenty-five or thirty men, women and children all intent on watching every movement and annoyingly silent except for an occasional giggle from the women in the rear of the group. There was never any unfriendliness manifest, however, and not once during the three winters did I have an unpleasant experience with the country people.

As we proceeded along the fossil ridge, visiting such pits as we found, working and examining such accumulations of dragon bones in farmhouses as we learned of, we would gradually gather a considerable collection, and this necessitated the employment of extra carrying-coolies, recruited locally, to carry the bones which were carefully packed in straw in large deep baskets with side loops through which the arms were passed, and we sometimes arrived back at Yen-ching-kou with our column doubled in size.

No matter how roughly treated by the excavator the dragon bones had been, as soon as we purchased them they became scientific specimens and were accorded the respect which a palæontologist has for his fossils. Even the coolies seemed to understand that the bones had assumed a new rôle as soon as they came into my hands, and they handled them accordingly. When the fossils reached the temple they were laid out in the working gallery where they were treated with the usual hardening solutions and the larger bones encased in paste bandages. Several times during the winter—especially toward spring—special trips were made into Wanhsien with specimens, and they were stored in our headquarters in the Customs temple until we were ready to go down river.

RELATIONS WITH THE VILLAGERS AND FARMERS

As March approached the weather became decidedly warmer, the winter crops took on new life and began to shoot up, and flowers appeared on the hillsides. It all reminded us that we were due back in Peking by April 1 for the first Mongolian trip, and we began to make our plans for departure. A series of feasts was tendered to us by the more well-to-do farmers, especially those belonging to the T'an family, and we in turn, under Wong's management, gave one grand feast in our temple, inviting everyone who had entertained us and a few of our village friends besides. A local cook with an assistant was employed, special foods, such as sharks' fins, dried sea-cucumber and seaweed, were ordered from Wanhsien, and the temple kitchen was utilized for the first time during our occupancy.

Three tables, each seating eight, were set on the shrine platform, and our own boys assisted in the serving. The feasts which had been given to us were of typical Szechwanese foods, which I found the most appetizing of any Chinese food I have ever had, but we desired to make a special feast with sea foods and other imported things, and our effort apparently made a hit with our guests, for they were still talking about the affair when we returned to the village the following winter. Our relations with the villagers and farmers were always cordial, and I think they really enjoyed our living among them; we brought considerable money into the community, we furnished diversion and entertainment to a people whose lives are ordinarily drab and monotonous, and by our presence, we guaranteed a certain amount of protection to the village against robbers and marauding bands of soldiers.

We also ran a medical clinic—nearly every foreigner in the interior does—and every other day our temple was open for the treatment of wounds and ills of various kinds. I knew nothing about medicine, but I did have a rudimentary knowledge of the use of antiseptics, and as the great majority of the cases presented to us were festered sores, usually from dog bites, we were able to give a good deal of relief and probably saved a life or two. We never charged the patient for treatment or medicine, but I noticed at Chinese New Year my Number One Boy, who assisted in clinical work, was overwhelmed with presents of all sorts which I took to be in the nature of *kumsha* from the patients. Wong and I were not forgotten at this time either, and we were showered with gifts which ranged from eggs and live fowl to large, highly colored medallions of puffed rice. This medical work probably did as much as anything to establish our standing in the community and enable us to carry on the work of fossil collecting about which there was always a considerable amount of suspicion and misunderstanding on the part of the natives, a public museum being something beyond their conception.

PREPARATIONS FOR DEPARTURE

On February 22, 1922, we packed up our collections and belongings preparatory to leaving, and invited in to tea the elders of the T'an family and paid to them the Chinese equivalent of $7.50 for rent of their temple for five months. They seemed highly pleased at receiving the money and asked us if we would favor them by posting a notice on the temple door to the effect that we would be returning in the autumn and were still the official occupants; all this being for the benefit of soldiers or militia who might wish to take the temple over for residence. On the following morning we left our temple behind a procession of twenty-one carrying-coolies and were conducted beyond the limits of the hamlet by two villagers with firecrackers suspended from poles—the Chinese *bon voyage* and a final mark of respect to us.

BY JUNK FROM WANHSIEN TO ICHANG

At Wanhsien, reached late in the afternoon, we found that our friend Asker had already chartered a small junk for our trip down through the Gorges to Ichang. The junk was lying moored to the rocks just below the Customs temple and my party went aboard and took possession. The river was almost at its lowest point, being two or three feet above the zero mark, and even the smaller steamers were not navigating the Gorges so that a junk was the only means of transportation left us. This particular craft was some forty or fifty feet long, drew about two feet of water, and had a crew of sixteen, including the *lowda*, or captain, and a cook and his assistant. The large crew is needed at the sweeps because it is necessary to maintain a steering headway which means traveling faster than the current, and in the rapid water the oarsmen have to strain to their utmost.

Quarters for Wong and myself were amidships under an arched roof of matting. Our boys and the *lowda* slept astern under a permanent roofing, and the trackers at night rigged up a mat covering forward and slept on the deck just where they stood at the sweeps during the day. As I have said before, the upper Yangtze is too dangerous for navigation after dark, and nightfall finds all steamers, junks and sampans either anchored or moored to the bank.

The two days following our arrival at Wanhsien were spent in packing our collections and equipment and paying our respects to friends in town. We found that we had thirty cases of fossils, nine of birds, mammals and reptiles and seven of equipment, besides numerous duffle bags and bundles. These were all stored in the rather shallow but spacious hold of the junk below the movable planks which formed the deck. At daybreak on February 26, after a farewell dinner given by Mr. Asker the evening before, we pushed off and began our seven days' trip to Ichang.

Any trip through the Yangtze Gorges in a junk at low water is pretty

sure not to be monotonous and it very often is not uneventful. Our voyage was for me extremely interesting and at times exciting even though we had no serious adventures. I can heartily recommend this trip to anyone suffering from ennui. If the river itself, with its rapids and rocks, does not furnish thrills enough, the human element along its banks can generally be relied upon to do it. For the first twenty miles below Wanhsien, to the first rapid, known as Hsin-lung-t'an, we were escorted by the U. S. Gunboat "Monocacy" which took us past a particularly bad nest of bandits who had been annoying river men for some time. The gunboat would have gone farther with us but it could not at low water return through the first rapid. Below the Hsin-lung-t'an we had to proceed without protection but fortunately it was not needed. The trip from Wanhsien to Ichang should ordinarily be done in four or five days, but we were delayed by strong up-river winds which sometimes necessitated our mooring the junk, as we could not make headway even with the combined aid of the current and the oarsmen.

We encountered no bandits but were shot at two or three times by soldiers who demanded that we turn inshore and submit to examination. This was all more or less official, though, and we were not molested. At one point near the Szechwan-Hupeh border, soldiers came aboard and inquired if we had rifles. Fortunately we had just been tipped off about this search and had just time enough to shove our two rifles under the blankets on our cots and only the shotguns were exposed. These the soldiers waved aside as being unimportant, and a package of cigarettes apiece hastened their departure. At two rapids, Hsin-lung-t'an and Hsin-t'an, we went ashore and walked around the rapid, joining the boat below, and at the Hsin-t'an, the worst rapid on the river at low water, I had the cases of specimens and our personal baggage taken ashore and carried around by coolies. This cost us perhaps two hours' delay in time and four dollars in money, but it seemed cheap insurance on the collections we had come so far to get and had spent a half-year in making. Wrecks at Hsin-t'an were of almost daily occurrence at low water, and the thought of our own junk dashed to pieces on the rocks below the rapid prompted the precaution.

It was early spring as we passed through the Gorges, the fresh green of the steep hillsides and the flowering fruit trees, adding their touches of pink and white, enhanced the beauty of this marvelous scenery. In the quiet deep water stretches of the gorges themselves, with neither rocks nor bandits to think of, we enjoyed this beauty of nature to the utmost. It is in the more open stretches between the several gorges that the dangers lurk; here one is apt to forget the scenery and find himself wondering how the junk is possibly going to miss the rock just ahead toward which the swift current is taking him, or else with field-glasses he watches the little group of soldiers along the shore to see if they

are going to take a chance shot at the boat, or he examines the gathering of natives in long gowns and tries to determine whether they are bandits or peaceful farmers. In spite of the great beauty and the thrilling interest of this trip, I know that I felt a decided relief and a let-up of tension when Ichang came into sight on the afternoon of March 4.

FROM ICHANG TO PEKING

Things were quiet again in Ichang. The Szechwanese had failed in their attempt to take the town and had returned to their own province—in fact we saw long columns of them marching back on the narrow trails along the river bank as we came down. A little Customs formality and arrangements for our passage down to Hankow and the discharging of our junk and our business was over, and while we waited for our steamer I had the pleasure of again seeing Consul Smith and presenting him with some of the fossils we had obtained as a result of the information he had communicated to the Survey. The journey to Hankow by boat and from there to Peking by rail was uneventful. We reached headquarters on March 13, to find the party gathered and in the midst of preparations for the great venture in Mongolia. For the next six months Szechwan was pretty much forgotten.

SUCCEEDING SEASONS AT YEN-CHING-KOU

The story of the second and third winters' work at Yen-ching-kou, 1922–1923 and 1925–1926, would be a good deal like that of the first winter, 1921–1922. We left Peking in the autumn, proceeding directly to our Ancestral Hall, remained there until early spring and then returned to Peking to be in readiness for the Mongolian work which always began about April 15.

There was just one change in our life in the temple these later years. Mrs. Granger, who traveled with me as far as Wanhsien in 1922, came out to Yen-ching-kou on visits two or three times that winter, and on the last trip, 1925–1926, she remained in the temple throughout the season. Mrs. Nelson also was with us for a month in the spring of 1926, following the close of the river exploration, conducted by Mr. Nelson, which began at Ichang and ended at our landing at Pai-shui-chih.

This presence of women in the temple proved a bit disconcerting to the T'an family elders. While they were pleased to have me and my party use their Ancestral Hall as a residence, and while they had no particular objection to our wives living there during the day, the idea of a woman, even a foreign woman, sleeping there at night was something entirely unheard of and therefore impossible. It just wasn't done. I was given to understand that the departed ancestors would turn over in their graves if such a thing took place. The elders had been so friendly to us that I was not inclined even to argue

the point with them, and so whenever Mrs. Granger and Mrs. Nelson were present in the temple, we arranged for sleeping quarters at the inn next door. Attic rooms were provided which fortunately could be reached by a passageway from the back of our court, and as the inn was not a very noisy one and the rooms were reasonably clean and at least thirty feet from the pig pen, it was not so bad after all, especially as the ladies were permitted to maintain dressing rooms in the temple. On two occasions, when we were threatened with bandit raids at night, I ventured to take my wife into the temple regardless of what the family, both living and dead, might think of it. We could protect ourselves in the temple but not in the inn. Apparently these violations were understood and accepted by the elders for I heard no comment from anyone.

On the second trip, 1922–1923, our former host in Wanhsien, Mr. Asker, had been transferred to another post, and so we made our headquarters at the China Inland Mission, although Mr. Asker's successor, Mr. Annette, gave us the use of the Customs temple for storage purposes and assisted us in many other ways. The third season, 1925–1926, the Expedition was harbored by Mr. Walter Jenkins, of Gillespie and Sons, wood oil exporters, and he was a most genial and helpful host.

SEASON OF 1922–1923

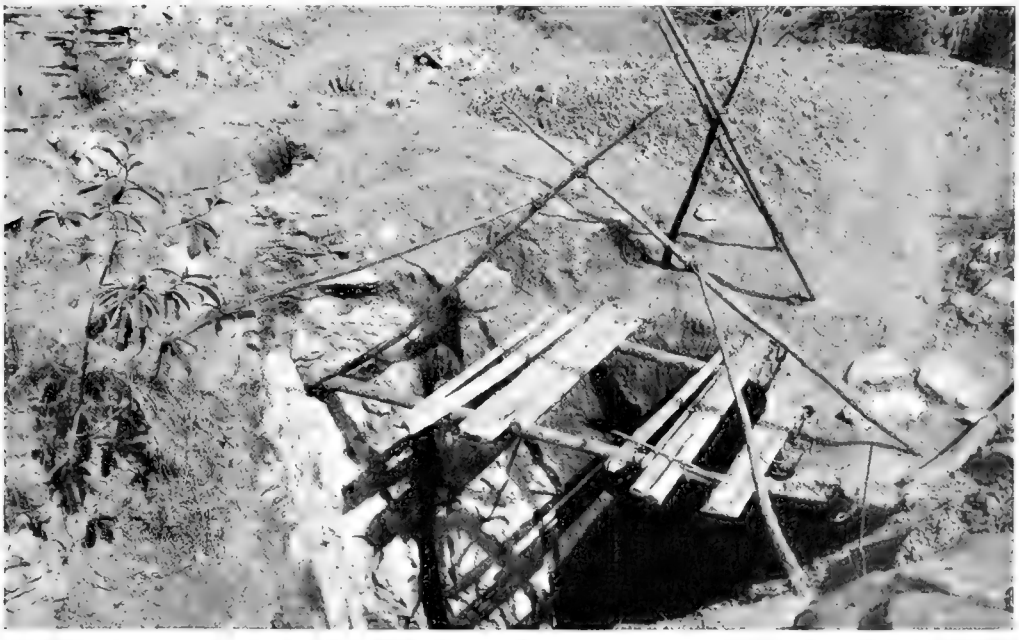
The second season we returned down river by chartered junk as we did the first time, being convoyed down to the Hsin-lung-t'an by an American gunboat and then proceeding to Ichang unescorted. A little variation and diversion was furnished this time by a small band of robbers in the Wushan Gorge who opened fire on what they apparently thought was a peaceable little party ready to turn inshore at the first shot and allow their boat to be rifled of anything the bandits might fancy. It so happened that we had on board two American sailors from our escorting gunboat, the "Palos," who were being transferred down river and whom we were taking along as passengers at the request of Commander Simpson. These two men with their side arms entered joyously with our own party into the fusillade which came from our junk, and the bandit party was broken up in short order with no casualties on our side.

SEASON OF 1925–1926

On the third trip down to Ichang, in the spring of 1926, we were able to take advantage of a newly established line of small high-powered steamers designed to make the run through the gorges even at lowest water. I did not care to take the time and risk involved in a third trip by junk so long as we could make the journey in comparative safety and in a single day by steamer. The time saved on the trip from Wanhsien to Ichang, however, was lost on

PLATE CXIX.

A. A HIGHLY FOSSILIFEROUS PIT IN WORKING ORDER ON THE DRAGON BONE RIDGE.



B. AN ABANDONED PIT.

This was excavated to a depth of fifty feet and yielded many fine specimens of the larger forms, *Rhinoceros*, bovids and *Stegodon*.

A. FLAG AND BANNER ON THE YEN-CHING-KOU TEMPLE.

The banner reads "American Museum Representative."

B. ON TOP OF THE DRAGON BONE RIDGE.

Party returning to Yencheng [illegible] Yen-ching-kou in the Valley of the Yellow [illegible]. The tents are those [illegible]

C. ON THE DRAGON BONE RIDGE.

A highly fossiliferous pit in working order. The children and women are engaged in gleaning fragments of bone overlooked or discarded by the workmen. Several specimens of the giant panda came from this pit.

D. THREE TONS OF DRAGON BONES.

Piled in the corner of a room at Pai shui chih. These were the property of a wholesale drug merchant of Wanhsien and represent the output of many pits. They were probably all eaten by Chinese patients during the following year or two.

the lower river, for when we arrived at Hankow we found warfare in full swing along the railway line to Peking, with trains entirely suspended, and after waiting several days I finally repacked the specimens and shipped them from Hankow, and the party proceeded to Peking by boat by way of Shanghai and Tientsin—a journey of nine days instead of the usual thirty hours.

INTER-PROVINCIAL WARFARE, 1922–1923 AND 1925–1926

Inter-provincial warfare affected us somewhat at Yen-ching-kou during the second and third seasons. The first year we encountered warfare at Ichang, but the second season it came nearer home. It seems that one of the younger Szechwan generals named Yang Sen had been driven out of Wanhsien a year or two previously and had gone down river into Hupeh to the area controlled by his friend and backer, Wu Pei-fu. Early in the winter of 1922–1923, he had, with General Wu's assistance, recruited an army and brought together equipment and ammunition and started back to retake Wanhsien by approach through the back door of northwestern Hupeh. When we arrived at Yen-ching-kou in the early winter, we heard reports of the approach of General Yang Sen across the Hupeh border to the south of us. Some fighting took place between Yang and the defenders from Wanhsien and then both sides intrenched for the balance of the winter.

In early March, however, we got reports of renewed activity, and when I was in Wanhsien on one of my periodic trips I learned that the defending troops were being defeated and would doubtless soon fall back on the city. Coolie-drafting had already begun on the streets, and so I hastened back, desiring to reach our camp ahead of the retreating soldiers who would be likely to loot the village and, perhaps, our temple if I were not present. Chow secured a sampan and three coolies after much effort, and we made the trip to Pai-shui-chih without trouble. At the landing, though, we encountered groups of the retreating army who were impatiently waiting for transportation down to Wanhsien and who commandeered our sampan before it touched the shore. It was only after considerable wrangling that I got my gear ashore before the soldiers took possession. Then followed the attempt to gather carrying-coolies for our trip inland and with not a man in sight. This was one of the times when we had to appeal to the local gentry who finally routed out the necessary men from their hiding, under beds and piles of rubbish in dark back rooms where they had gone to escape the *lafu*. On the trip to Yen-ching-kou we found the road deserted by all except soldiers who were headed toward the river. Many of them were wounded and were being sent on ahead. Their wounds were usually tied up with dirty rags, they were mostly barefooted and they had a generally dilapidated and dejected appearance. They offered no discourtesy to us, though, and we reached our temple at dark to find Wong

holding the fort and reporting that nothing unpleasant had happened during the day.

The retreating soldiers had by that time begun to stream down the hill back of the village, and although we closed the front doors it was necessary to keep my party up most of the night. About every group of soldiers that arrived in the village after dark came to our door, pounded upon it and demanded shelter. Wong and I would go down and he would shout out at them that the temple was being occupied by a foreigner and then if they questioned him he would open the door and throw the flashlight upon me, after which the soldiers would slink off with a few disgruntled remarks.

Toward midnight, after it had begun to rain, two young officers appeared at the door and announced that they had sixty men with them and that all available shelter in the village had been taken and requested that we give them accommodations. It seemed discreet to do this, especially as the men were under control of officers, and so we took the two officers up on our balcony, while their men, each with big bundles of rice straw taken from the nearest stack, spread themselves out in the court below under the balconies and were all asleep in ten minutes. Their bugler waked them at daybreak and shortly afterward they were off on their march down the river.

From shortly after breakfast until dark the retreating army was filing past our door; early the next morning the advance-guard of General Yang Sen's victorious army reached the village and it was nightfall before the rear-guard passed. During most of these two days I sat on the temple doorstep and watched this extremely interesting but pitiful spectacle of Chinese armies on the march.

The men, of necessity, marched in single file and at a fast walk—sometimes breaking into a dog trot for a short distance. Groups of soldiers were interspersed with groups of carrying-coolies, probably one coolie for four soldiers. The soldiers carried nothing but their guns, belts of ammunition and their umbrellas. Bedding, food, cooking utensils, camp furnishings, cases of ammunition, machine guns and a few light field pieces were all on the backs of coolies. Such wounded as were not able to walk were carried on litters by coolies, and officers of high rank rode in their carrying-chairs.

The majority of these carriers were middle-aged or elderly coolies—men who were hardly capable of carrying heavy loads, but who managed to stagger along, groaning at every step, and kept going only by fear of the fixed bayonet held at their backs with which they were prodded whenever they faltered. At least four of these aged men died of sheer exhaustion between our village and the Yangtze, and probably a great many of them never returned to their homes because they were taken on across the river and into the country to the northward.

In times of coolie-drafting all young men of the farms and villages flee to the hills, taking with them the younger women, the children and such of their belongings as they can carry. Even the family pig is often driven along with them because that is usually the most valuable of their possessions. The old women and elderly men are left to watch the homes and then when the soldiers arrive looking for coolies they take what they can get, which accounts for the number of aged men pressed into this kind of service.

Shortly after the last soldier had passed through, we went out into the village street and found the people beginning to return to their homes from their hiding places in the hills. We found that no serious depredations had been committed by the soldiers. A certain amount of rice and other foodstuffs had been taken and some furniture had been broken up for firewood when other fuel was not available, but there had been no general looting, and beyond a few blows administered by the soldiers no bodily harm had come to anyone. Considering that two armies had just passed through, and especially as one was a defeated army on the retreat, the villagers were very lucky. Wong assured me that the presence of a foreigner in the village had much to do with the restraint shown by the soldiers and the villagers seemed to think so too. The poor little hamlet had had several visitations by soldiers, bands of religious fanatics and plain bandits previous to my arrival in 1921. Each had taken its toll and when I first went there the residents had little left but the walls of their houses, a few cooking utensils and very meager bedding. Water buffaloes, pigs and fowl had been killed or driven off, furniture smashed up for fuel and everything worth taking along had disappeared; and Yen-ching-kou is only one village of thousands in the interior of China to suffer in this manner during the chaotic times following the downfall of the Manchu dynasty in 1911.

COLLECTING DURING THE SECOND AND THIRD SEASONS

The fossil work of the second and third seasons was somewhat simpler than it was the first year. That year I obtained a splendid representation of most of the forms found in the pits, and my effort in the years following was to get any new or rare forms which might show up and to get other specimens —more perfect skulls especially—of the animals already represented in the collection. The later collections were naturally smaller in size but choice in quality as I took very little of the bulky skeleton material, such as limb and foot bones. By the end of our first season the excavators had learned what we particularly desired and in the following years we reaped the harvest—beautifully preserved skulls, excavated and handled with special care because the workers knew by then that the bonus paid for such specimens made it well worth their effort. The warfare in this district, which extended over into our last season, interfered somewhat because the men became timid about carry-

ing on excavation work with coolie-drafting and other soldier activities going on in the neighborhood, but we managed to find enough pits working to make our visits profitable.

RESULTS OF OUR WORK AT YEN-CHING-KOU

The collections of the three years give a very adequate representation of the animal life of early Pleistocene times in this region. It is a fauna of which previously we had just an inkling through the descriptions of fragmentary specimens by Owen, Koken and Matsumato, of specimens probably obtained from drug merchants and others along the upper Yangtze and the exact source of which was not known. The collection is important not only as giving a picture of the life of this particular region, but, being midway between fossiliferous deposits of the same age in north China and northern India, it helps greatly in working out the general distribution and migrations of mammalian life in eastern Asia during the Pleistocene period.

Early in March, 1926, we left Yen-ching-kou for the last time—again to the accompaniment of firecrackers and with the good wishes of the villagers, who have doubtless had their ear to the ground many times since listening for our return. The one regret we have is that, for political and other reasons, it has not been possible to send a representative back there during subsequent seasons. Doubtless the digging of "dragon bones" has been carried on each winter, for things change slowly in China, and doubtless hundreds of priceless scientific specimens are brought to the surface each year; it is equally certain that these priceless specimens have been eventually ground into powder and eaten by the superstitious and custom-ridden Chinese. Yen-ching-kou is only one of many places in China where this palæontological nightmare runs its course.

CHAPTER XLIX

A RECONNAISSANCE IN YUNNAN, 1926–1927

By Walter Granger

WHY THE YUNNAN TRIP?

The Yunnan expedition was a direct result of the failure of the party to get into Mongolia in 1926. The failure to get out that year was due entirely to inter-provincial warfare in the vicinity of Peking, and it is the only time in the ten years of the Expeditions that such warfare has prevented one of the major undertakings. Doctor Andrews has described this occasion in his narrative.

The final abandonment of the Gobi trip came late in July and it became necessary for the members who had gathered in Peking to return to New York, to take up other occupations in town or to engage in exploration elsewhere. To this last task Mr. N. C. Nelson and I set ourselves. I had been wanting to visit Yunnan ever since the Expeditions began and here was the opportunity. We were to carry on explorations in eastern Yunnan in zoölogy, palæontology and archæology, supplementing so far as possible the work of Doctor Andrews in western Yunnan in 1916–1917. I particularly hoped to find fossiliferous Pleistocene valley deposits, and Nelson wanted more especially to visit the Yangtze valley in the northern part of the province to find out if the Neolithic culture discovered by him in the Yangtze Gorge region extended that far up the river. The zoölogical work was considered of secondary importance and was to be carried on by me whenever opportunity offered.

DOWN THE CHINA COAST BY BOAT FROM TIENTSIN TO HAIPHONG

Our party, consisting of Mr. and Mrs. N. C. Nelson, Mr. and Mrs. Walter Granger, our old Number One Boy Chow, "Buckshot" and the cook Hui, left Peking on August 14 and proceeded to Tientsin for the journey down the China coast to Tonkin where one takes a railway to Yunnanfu, the capital of the province. A trip along the China Coast during the typhoon season is likely to be an eventful one and ours was. We were given a splendid chance to observe such a phenomenon from a safe vantage point.

The journey from Tientsin to Haiphong was taken in three stages on small coastwise boats—Tientsin to Shanghai, Shanghai to Hongkong and Hongkong to Haiphong. At Chefu on the Shantung peninsula, we met my old Yangtze River friends H. B. M. Consul Smith and Mr. Asker, both stationed there at the time. In the harbor of Wei-hai-wei, farther east on the peninsula, we rode out our first typhoon and at the Tai-chou islands, off the coast of Chekiang, we anchored for two days to permit a particularly vicious typhoon to pass.

Our small boat carried a wireless plant, and on the morning of August 23, one day out of Shanghai, the captain received a report of a storm traveling in our direction from the south. Shortly after that the sky took on a queer murky look and our steamer was headed inland toward a group of small islands behind which we dropped anchor at one o'clock. Several other small coasting steamers which came within range of our signals also headed in for the same berth and by nightfall there were seven of us anchored among the fish-nets in a shallow bay formed by the islands. By dark the wind had picked up to a gale and the rain fell in torrents and all the next day and night this continued. The water was driven through the roof of our dining saloon and in the Chinese quarters conditions were so bad that the passengers were moved below decks. By the forenoon of the second day the storm had abated and all ships proceeded on their way. The wind which at first blew from the southeast had gradually veered around to the west and finally to the north. We learned later that the center of the typhoon had passed inland at Wenchow, some fifty miles to the south, had then traveled northward and passed out to sea again near Shanghai.

At Hongkong we made arrangements for banking, purchased certain supplies for the winter's work and did some sightseeing while waiting for the tiny steamer which was to take us farther down the coast to Haiphong, our port of entry. At Haiphong, which is situated several miles up the Red River delta, we disembarked, passed through the French Customs with some delay but no particular trouble and were ready for the journey inland.

HAIPHONG TO YUNNANFU

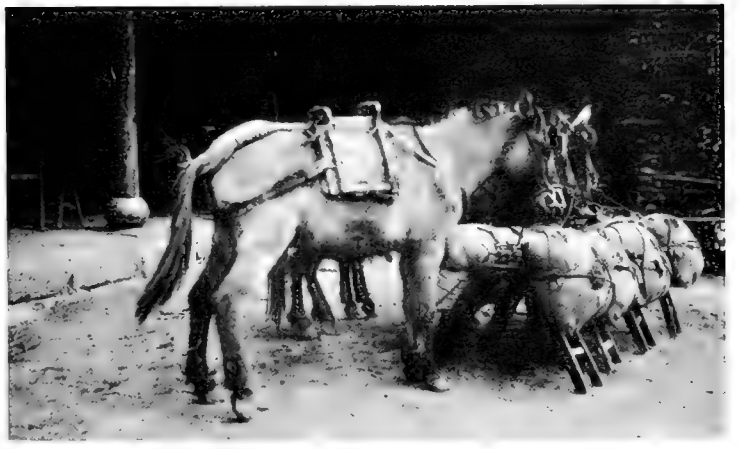
Hanoi, the capital of French Indo-China, is ordinarily but two or three hours' railway travel from Haiphong, but at the time of our visit the railroad was under water from the greatly flooded Red River, and the only means of communication between the two places was by means of tiny stern-wheel steamers which traveled the delta region. On one of these little boats, the "Saphir," we embarked late in the afternoon and spent a terrifically hot night passing from one delta branch to another by means of artificial channels and at daybreak reached the high ground to the southward, at Nam Dinh.

PLATE CXXI.

A. A STATION ON THE RAILWAY LINE TO YUNNANFU.

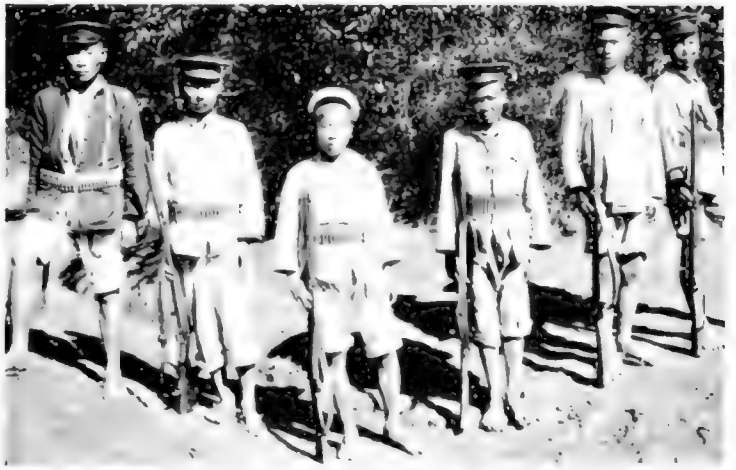
B. "VICTORY TOWER," YUNNANFU.

C. IRRIGATION CANAL ON THE OUTSKIRTS OF YUNNANFU.



D. PACK HORSES AND THEIR LOADS IN A CHINESE INN.
Showing pack train methods used in Yunnan.

A. OUR CARAVAN ON THE ROAD SOUTH OF YUNNANFU.



B. [illegible]

C. SUSPENSION BRIDGE OVER RED RIVER ABOVE YUAN KIANG.

D. WOMEN OF THE TAI TRIBE MAKING OFFERINGS AT A TEMPLE IN YUAN KIANG.

Here we transferred to the railway line coming up from Saigon and an hour's run took us into Hanoi.

Hanoi is at the beginning of the three days' rail journey to Yunnanfu. The first day, on the Tonkin line, takes one up the Red River to the Yunnan frontier at Lao Kai. Here the traveler stops over night and the next morning boards the narrow-gauge train and crosses a tributary stream into Chinese territory. After a short stop at the Chinese Maritime Customs Station, the long climb to the provincial capital begins. This second day's journey is most picturesque. The train climbs slowly up one side of a long, steep-sloped tropical valley with wild banana plants fringing the track, crosses a short bridge near the head of the valley and returns on the opposite side but at a higher level and passing through dozens of tunnels on the way. Then the line crosses over a ridge and continues through extremely rough country to the walled town of Amichow which is reached by nightfall, and here the day's journey ends. After a second night at the none too attractive railroad hotels, still within the tropical belt and hot and damp, the last stage of the journey begins, and by mid-afternoon the train arrives at Yunnanfu, 6,400 feet above sea-level and delightfully cool and dry.

HEADQUARTERS AT YUNNANFU

We reached the capital on September 17, established headquarters for the season at the Missionary Station conducted by Mr. C. N. Mylne and immediately began plans for the winter's work. Banditry was rampant in the province and after several conversations with U. S. Consul Meyers, the Chinese Governor and his Secretary of Foreign Affairs, it was decided to make two major explorations—one south to Yuan Kiang on the Red River and the other northward to the southernmost bend of the Yangtze River. These two routes were reported to be comparatively free of marauding bands, but we were cautioned that even here we must pass on from one magistrate to another, reporting at each office and taking such soldier guard as each official deemed necessary for the next stage.

We had no definite object in mind—our purpose being merely to travel leisurely these two routes, Nelson to watch out for things of possible archæological interest and I to look for recent sedimentary deposits which might contain fossils and to do such zoölogical collecting as opportunity afforded—strictly reconnaissance work.

Practically all traveling in Yunnan is done with pack trains of small, sturdy horses. With Mr. Mylne's assistance we obtained the services of a *mafu* who brought together the animals required for our caravan, selecting the two largest and best for riding horses for Nelson and myself, and on October 16 we started out on the Red River trip.

The month at Yunnanfu, between our arrival and the start on the southern trip, was not spent in idleness. Nelson made many short excursions in various directions in search of things of archæological interest but without much success, while I turned my attention mostly to zoölogical collecting. We were told that by mid-October the rains would be finished, and we prolonged our departure somewhat on this account because the Yunnan rainy season is something to be reckoned with. I quote from Mr. Nelson's diary covering this period:

"*Sept. 17–Oct. 15.* Made excursions from Yunnanfu into the foothills southeast, east, northeast, north, and northwest from 1 to 3 miles, observing both the surface and road exposures. Saw only limestone exposures and bowlders, with an occasional fragment or pebble of sandstone—the latter mostly in streambeds. Found no trace whatever of worked stone or of habitation sites. In a new road cut outside the North Gate in the West Wall I observed glazed potsherds, probably filled into old gullies and ravines. Potsherds were also observed at the base of the earth portion of the South Wall, on the inside between the two south gates. Some age is implied in both cases, but there were no traces of worked stone.

"Examined also heaps of stone and tile fragments, etc., which had been gathered from adjacent fields, but without results.

"Examined cemeteries southeast, north, and northwest of town. Potsherds and other things occur here at some depth, but no worked stone."

THE RED RIVER TRIP

Our route to the Red River lay along the western shore of Kun-yang-hai, a large lake with its northern end almost at the gates of Yunnanfu. The horses were sent around the end of the lake but our party took boats and was rowed over to a temple at Kao Chiao where our first camp was established.

COLLECTING AT KAO CHIAO TEMPLE

The rainy season, which should have been over by the end of September, was having its last wild fling, and for six days we were marooned in this temple unable to proceed on our journey. Nelson, between downpours, examined small caves and shell-mounds, while I, with the assistance of Buckshot, found enough zoölogical collecting to keep me busy. We finally, in desperation and with the rains still going strong, left this camp on the twenty-first and five days later reached the southern end of the lake.

THE ILLNESS AND PASSING OF HUI

On the way down, our little cook, Hui, who had not been well at the start, became so ill that I put him aboard the little steamer which plies the lake daily,

and sent him back to Yunnanfu with instructions to go to the English hospital there. This he did and he remained in the hospital on and off until midwinter when he died—the first and only death on the Expedition during the ten years of its activities. Hui had been with us since the first trip in 1921 and was an excellent cook and loyal servant and we all felt a personal loss in his passing. He was buried in a small cemetery outside of Yunnanfu—one devoted to people from the northern provinces, and later I had a suitably inscribed tombstone erected over the grave. The Number One Boy, Chow, carried on with the cooking for the rest of the season but the loss of Hui was felt to the end.

A TRAIL IN MOUNTAINOUS COUNTRY

From the south end of Kun-yang-hai, the Red River trail enters rough mountainous country, typical of all Yunnan except around the few lakes of the province. The trails are merely paths just wide enough for two loaded horses to pass, and along rocky sidehills there is not even room enough for that and special recesses have been cut into the hills at intervals where one caravan can be crowded in while another passes by. This necessitates much hallooing ahead on the part of the *mafus* to prevent the caravans meeting on a narrow stretch of trail.

A SOLDIER ESCORT

We now had to take on extra soldiers for escort because the country was wild and bandits had been appearing along the road from time to time. The magistrates, on whom we always called immediately upon entering a town, and who were really responsible for our safety, usually insisted on our taking from six to ten soldiers. These guards were supposed to be furnished gratis, but it was generally understood that each man would receive from us the equivalent of about ten cents a day, probably the only pay they did get from any source. Just what service they would have been in case of an attack we didn't know, but we were not permitted to proceed without them, nor are foreigners allowed to travel anywhere in the province without such escort.

THE SERIOUS ILLNESS OF CHOW

At the village of Yang-wu-pa, about three days' travel from the Red River, another serious illness in the party developed. Chow, who had been taking the cook's place in the outfit, and who had had an unusually hard day of travel over rough country and along miles of stream-beds, was suddenly taken with pains in the middle of the night and kept everyone in our little temple awake with his howlings and groanings. Neither Nelson nor I could diagnose his trouble, but I suspect that opium, or rather the lack of it due to the exigencies of travel, had something to do with it. At any rate for three days we were obliged

to remain here until Chow was well enough to be carried on a litter to Yuan Kiang. Here we knew there was a physician, Dr. Charles E. Park, connected with the Presbyterian Mission, and we were anxious to get our patient there as soon as possible. As a matter of fact Chow became excess baggage from then on until our return to Yunnanfu nearly six weeks later. For four weeks we remained on the Red River with Chow who refused either to get well or to die, and we had to stay with him. We had brought the boy from his home in North China and could not leave him at the point of death in an extremely out-of-the-way place and among inhospitable people—mostly tribes people whom the Chinese detest. An expedition which deserted its servants under these conditions would have difficulty in ever again getting together an adequate Chinese personnel. The boy, with Doctor Park's assistance, did finally get well, although we had to carry him back from the Mission Station to the head of Kun-yang-hai where we sent him on to Yunnanfu on the same little steamer that had carried poor Hui back. Incidentally, Chow as a loyal Chinese gave the credit for his recovery, not to Dr. Park but to Confucius, before whose image in the temple at Yuan Kiang he burned candles and incense throughout the last night of our stay.

YUAN KIANG ON THE RED RIVER

Yuan Kiang, a few miles north of the Tropic of Cancer, was reached on November 10 and we went into camp in a fine spacious temple just outside the city. The town itself is a wretched, dilapidated place deserted by all but the necessary officials and soldiers, a few shopkeepers, innkeepers and other people who live on trade from passing caravans. Many of the dwellings are collapsed or deserted and the walls of the city are tumbled down in many places and are patched up only when there is threat of a bandit raid. The place has some political importance because it is the only Chinese town in the river valley for a long distance, and apparently at one time it was a thriving city, being on the main caravan route to southern Yunnan and Siam. Its present decay seems to be attributed entirely to the malarial mosquito which infests the Red River valley and of which the Chinese are afraid. Caravans passing along this trail never stop in the river bottom more than one night, and not at all if they can possibly travel from the high land on one side to that on the other in one day. Practically every resident of the town shows the effects of malaria, mixed with opium, and altogether it is the most woebegone place imaginable. The broad valley is rather densely populated but by people of the Tai or Shan race and not by Chinese. The Tais cultivate all available land—mostly rice—and live in villages of closely packed mud-walled flat-topped houses. In language, religion, dress and social customs they are totally unlike the Chinese.

AT THE MISSION, NEAR YUAN KIANG

The Presbyterian Mission, which is located four miles from Yuan Kiang, is distinctly a Tai Mission, a northern branch of the Presbyterian Missions in Siam which is the real home of the Tai race. Doctor Park called upon us in our temple as soon as he heard of our arrival and invited us to make his place our headquarters. So a day later we moved out to the Mission, established Chow as the first patient in the newly constructed mud-brick clinic building, and settled down to enjoy the hospitality of Dr. and Mrs. Park until our patient should be recovered. Here we stayed for nearly a month, Nelson carrying on his archæological investigations, but without any very satisfactory results, and I, in the absence of any palæontological possibilities, doing zoölogical work. During this time we made many short side trips under Doctor Park's guidance, sometimes up or down the valley to various Tai villages and once to a tribe's village high up in the hills above the Mission, where Nelson found something of special interest to him in the manufacture of pottery. On one occasion Nelson accompanied Dr. and Mrs. Park on a trip up the Red River valley, two days' journey, to the older Presbyterian Mission at Mosha. The Yuan Kiang Mission was only just being established and the two residences were in course of construction while we were there—the Park family living temporarily in a thatched bamboo structure, and with Doctor Park performing major operations on a linoleum-covered packing case on the porch.

THE RETURN JOURNEY TO YUNNANFU

The return journey to Yunnanfu, which began on December 9 and ended on the 21st, was without particular incident. The route back was the same as far as the southern end of Kun-yang-hai and then we went up the east side of the lake, giving Nelson further opportunity to examine shell-mounds. I quote again from Nelson's diary his description of the largest of these shell heaps which we encountered:

THE TA-HU-KAI SHELL HEAP ON THE SHORE OF KUN-YANG-HAI LAKE

"Friday—December 17th. . . . Discovered a good sized shell heap (Site No. 11) situated at the extreme southeast corner of the lake, near the village of Ta-hu-kai. The refuse occupies a small isolated hill lying about 100 feet off the mainland and is passed by the trail on the south side. The hillock is about 150 feet across, and 250 feet long, orientated approximately east and west. It is washed by the open lake waters on the north and rises some 35–40 feet above the lake level. The shell deposit occupies only the top portion but measures 75 x 150 feet and in two places, where measured, reaches a depth of about 2 feet; in a third place (southeast corner) it measures over 3 feet.

Digging revealed almost a clear shell with but little black dirt. A few red and gray potsherds were found, but no bone or worked stone."

RESULTS OF THE RED RIVER TRIP

The shells which compose these ancient heaps are all of one sort—a large coiled shell of the genus *Melania*. They abound in the waters of the lake and are to-day used for food by the Chinese just as they were in ancient times. Nelson dug into many of these mounds, finding occasionally a bit of pottery but never a worked stone and never anything by which he could even approximately date the mound. The only stone implements found on this southern trip were two or three found on the surface—one of these actually in the trail. It was not possible to date them, and they have, therefore, very little significance. Throughout the trip not a trace of native stone suitable for the making of implements was encountered, and this fact probably tells the story. The rocks were all either shale, sandstone or limestone. Nothing harder. The zoölogical material obtained, mammals, birds, reptiles and fishes, was desirable because it came from parts of Yunnan not previously represented in the Museum collections, but the archæological and palæontological results were largely negative. Nelson reported the examination of sixteen archæological sites and twenty caves. All I could report for palæontology was a few fragments of a large artiodactyl found at a depth of nine feet in the Red River valley filling. There was probably no great age attached to these bones and yet they seemed to be true fossils and they were found below the lowermost deposits of cultural material.

OUTFITTING AT YUNNANFU FOR THE NORTHERN TRIP

Christmas week was spent in Yunnanfu in holiday-making and in preparation for the Yangtze River trip which was next on the program. This northern journey required somewhat different equipment. It was now midwinter and our route lay at higher altitudes and more northerly latitudes. Light frosts are occasionally felt in Yunnanfu, and on some of the higher stretches on the road to the Yangtze we expected and actually did encounter freezing weather.

THE TRIP TO THE YANGTZE RIVER

We left headquarters on New Year's Day. The route was that which passes through Wu Ting and Ma Kai and on across the Yangtze into south central Szechwan. The road is fully as rough as the one to the south and rather less interesting as a whole. Also it was more bandit-infested and while we did not actually encounter the bandits we were close to them at times and were kept rather anxious over much of the journey.

PLATE CXXIII.

A. PRESBYTERIAN MISSION AT MOSHA ON THE RED RIVER.

B. EXPEDITION HEADQUARTERS AT THE PRESBYTERIAN MISSION OF YUAN KIANG.

C. KAPALA.
A mountain village of tribes people above the Mission at Yuan Kiang.

D. VILLAGE OF KAPALA.
Potters at work with wheel.

A. ONE OF THE BEAUTIFUL ARCHED BRIDGES COMMON IN NORTHERN YUNNAN.

B. A MIAO WOMAN SPINNING HEMP AT THE NATIVE VILLAGE OF SAPUSHAN, NEAR WU TING

C. MR. NELSON AT LUNCH IN THE LUNG KAI TEMPLE.

D. CONFLUENCE OF THE MA KAI RIVER WITH THE YANGTZE.

AT THE MIAO INLAND MISSION AT SAPUSHAN

At Wu Ting we stopped over a day and made an interesting side trip to the Chinese Inland Mission station at the Miao village of Sapushan which is on top of a mountain overlooking the Wu Ting valley. We found a Mr. and Mrs. Fleishman in charge of the Mission and they very kindly took us over the village. I quote Nelson's diary observations on these tribes people:

"The houses are simple gabled structures with rice thatch, a door in the middle, and a couple of small square holes serving as windows. Most of the work was being done outdoors. One woman was making an elaborate wedding garment for herself and another for the bridegroom. The women wear a skirt and a short jacket; the men loose trousers and a long jacket or coat (several in fact), all made of hemp in natural buff color for the men but dyed green, blue, and red for the women. The wedding clothes were fundamentally of hemp, but ornamented with strips of colored cloth of Chinese origin, making geometric figures, which in addition were ornamented by embroidery done with simple long stitches in yellow and other colored threads. The man's garment had a broad square collar hanging down the back, at the bottom of which were fringes to which were attached little bells and cash coins. The main garment was a grand coat. . . .

"Another woman was found outdoors spinning hemp on a real but home-made spinning wheel run by foot power. The wheel had a broad skin belt which ran up over a carrying piece of wood on which were four shallow grooves, into which fitted four spools, all running and spinning at once. The hemp bark was evidently soaked in water and was already joined into a continuous strand. The principle of spinning and winding up was the same as that used by the Tai in spinning cotton.

"We saw or were told of the Miaos growing wheat, oats, barley, buckwheat, and maize; also pumpkins and potatoes and some other garden truck. They keep cows, goats, pigs, and chickens. Burn a great deal of firewood, keeping up blaze all night. The people are rather short and stocky; rather flat faces, low-bridged noses, pronounced lips. Hair both black and brown. Trial marriage usual."

FOREIGN TRIBES IN SOUTHERN CHINA

Here, as in many other places in Yunnan and southern Szechwan, are people living in China but not of it; people often with a pronounced Caucasian suggestion in their features and unlike the Chinese in every way. They very likely were there before the Chinese, but they have been overwhelmed and to-day find themselves living in isolated groups such as at Sapushan. Their lives have undoubtedly been much influenced by the Chinese who surround them but they still maintain their tribal customs to a remarkable degree.

There are many distinct tribes of non-Chinese in Yunnan, but the Nosu, or Lolos as they are commonly called, and the Miaos seem to predominate.

BANDIT-INFESTED COUNTRY BEYOND WU TING

The first day's journey beyond Wu Ting took us into the edge of the worst bandit country, and the Commandant of the local garrison which was quartered in the temple where we stopped told us that we could not proceed until his soldiers, who had already been sent out, had cleared the trail ahead. Three days later we were permitted to start but under heavy escort. A long day's travel over extremely rough country finally brought us down, after dark, into the Ma Kai valley.

IN THE MA KAI VALLEY

Here we observed, the next morning, the first and only fossiliferous sediments encountered in Yunnan. I found that the Upper Ma Kai valley, several miles in breadth, had at one time been filled to a depth of perhaps 200 feet with a fine pinkish sandy material, probably æolian or wind-borne in origin, and that much of it still remained from modern erosion as remnant masses. I had heard from missionary friends that fossils had been found here and as we passed rather hurriedly through it on our way north I examined it along the trail and found some fragmentary bones, the first unquestionable fossils to be observed, but we left the careful search until our return because of the bandit menace which prompted us to get to Ma Kai as soon as possible.

AT THE CITY OF MA KAI

At the city of Ma Kai we found the officials all very jumpy and expecting a bandit attack at any time. The gate was closed on us, a rather novel experience, and not until we had been scrutinized thoroughly by various soldiers and others from the top of the wall and our cards had been sent in to the Magistrate were we allowed to enter. Once inside we were treated well enough, and the Magistrate, who received us in his smoking room, chatted amiably while he smoked six pipes of opium and offered us a heavy escort for the rest of our journey.

The Ma Kai valley runs directly north to the Yangtze and down this we traveled for a day and a half after leaving the city of Ma Kai and reached our destination at the village of Lung Kai on the Yangtze on January 16. We found the river here to be from 100 to 300 yards wide and swift-running. Not so big, of course, as in the Gorges but still a mighty stream.

AT LUNG KAI ON THE YANGTZE RIVER

It was market day when we arrived at Lung Kai and the market place was crowded with the tribes people of many races. Chinese probably predomi-

nated but the tribes people had come in from the hills in great numbers and added variety to the scene. The men of the various tribes often wear ordinary Chinese garments and are not at first glance distinguishable from the Chinese themselves, but the women without exception wear their native costumes, which are usually much more picturesque than the Chinese dress and always serve to identify them.

NELSON FINDS A NEOLITHIC CULTURE SITE AT LUNG KAI

We went to camp in the main temple in the center of the village, and the next day Nelson began the search for evidence of Neolithic culture which he had found the year before along the river a thousand miles downstream in Hupeh and Szechwan. For two days Nelson tramped the river bank on both sides looking for implements and found none. The shingle banks were there just as on the lower river and they contained material suitable for implements but there were only faint traces of worked stone. This was disappointing and it looked as if the culture, so much in evidence below, had never reached this far up. On the third day, however, he chanced to visit an isolated hill some distance back from the river and at the base he saw the first worked stone fragments. Following them up the slope of the hill he discovered a true Neolithic site on top, and two days of careful exploration of this hill yielded 200 specimens. About 75 of these were stone flakes, some retouched and some not, but the balance were more or less completed implements of various sorts. The list includes hammerstones, axes, chisels, scrapers, a rubbing stone and a polishing pebble; all quite similar to the artifacts found in the Gorge region. The prize of the lot, however, was a beautiful jade hatchet blade which was unlike anything found below.

EARLY PLEISTOCENE FAUNA IN MA KAI ÆOLIAN DEPOSITS

The discovery of this one site at Lung Kai made our northern trip worth while and we started back feeling that we had at last accomplished something. At Ma Kai our friend the Magistrate was much worried over our safety on the return journey and gave us an extra heavy guard, about twenty soldiers, and instructed us to get over the first two stages as rapidly as possible. I could not, though, leave those fossiliferous sediments entirely unexplored and so we took a chance and held the party at the village where the trail leaves the valley and for a day and a half we scoured the exposures for fossils. It was not a rich deposit but we did get a small collection of identifiable teeth and jaw fragments, enough to place the fauna as early Pleistocene. The forms obtained were an extinct species of horse of the genus *Equus*, several artiodactyls, traces of Proboscidea and a rhinoceros. The exposures on the opposite side of the valley looked most promising and we longed to examine them

but dared not do so. There was a real danger back of the Magistrate's anxiety and we knew it, for this was a district which had been overrun with bandits for several years. So we reluctantly gave up a more thorough search and left for Peking, and less than a week after we left, an English missionary living near-by was taken and held for ransom. Some day, bandits permitting, this deposit will yield an important fossil fauna, and it is not at all impossible that it may contain evidence of early man. Just as the hill at Lung Kai was Nelson's important site so was this mine.

BANDITS PREVENT EXPLORATION OF AMICHOW CAVES

We returned to Yunnanfu exactly as we came out—making the same stages over the same route and stopping at the same temples and inns. Nelson figured out that on both the southern and northern trip we had made our temporary home in twenty-six temples and the majority of them we had visited twice. Headquarters was reached on January 31.

During February we made several short trips out from Yunnanfu. One of them was down along the railway to Amichow and Mengtze where we hoped to explore several caves of which we had heard reports. Once more we were blocked by bandits. Officials at Amichow would not permit us to go even a mile outside of the city walls without a guard, and as the Magistrate's statements of the dangers were backed up by the French railway officials we heeded the warning. One of the caves, a short distance back from the railway, which we had hoped to visit was actually occupied by bandits as headquarters! We did explore one large cave near the railway line, but that was all, and here we found nothing but modern Chinese culture in evidence.

At Mengtze, which is on a branch railway line south of Amichow, there is a lake of considerable size situated in a broad open valley. Nelson encountered here a few low mounds and other suggestions of an early occupancy, but there was nothing on the surface, and our limited time did not permit of excavations. Here again the absence of any material for making stone implements worked against the archæologist.

THE PRINCIPAL RESULTS OF THE TRIP TO YUNNAN

After returning from Mengtze we packed up our collections, made our adieus to the American, British and French Consuls, to our various missionary friends and to the Chinese officials, and left for Peking on March 15. This Yunnan exploration was intended only as a reconnaissance and it really was not much more, although a most delightful experience to both Nelson and myself. We did establish the Neolithic culture of the Yangtze valley at Lung Kai; we discovered one important locality for Pleistocene vertebrate fossils and we obtained a fairly good zoölogical collection from sections of the

province previously unrepresented in the American Museum. Furthermore, we paved the way for future archæological and palæontological work in eastern Yunnan.

The rail journey to Haiphong and the steamer voyage to Hongkong and then to Tientsin direct were accomplished without incident, and at dusk on April 3 our train pulled into Chien Men Station under the gray walls of Peking. We returned to Peking just at the time when China was becoming much aflame and anti-foreign feeling was rampant. At Hongkong we had heard rumors of the advance of the Southern army upon Nanking and of the danger to the foreigners residing there. At Wei-hai-wei the rumors were confirmed and by the time we had reached Peking it had become evident that the situation was entirely too dangerous and unsettled to permit of another expedition that year. Subsequent events, in the spring of 1927, are recorded by Doctor Andrews in his narrative.

CHAPTER L

ARCHÆOLOGICAL RECONNAISSANCE IN THE YANGTZE RIVER GORGES

By N. C. Nelson

PRELIMINARY ACTIVITIES

When political conditions in China were favorable the Central Asiatic Expeditions of the American Museum of Natural History devoted the summer portion of each year to field work in Mongolia and the winter months to collecting in various parts of southern China. Thus, in the spring of 1925, when I joined the Expeditions as archæologist, I accompanied the large field party which went from Peking to Kalgan and thence westward by motor lorries and supporting caravan through the southern portions of Inner and Outer Mongolia to the vicinity of Kobdo. Following our return to Peking in September of that year, preparations were made for spending the winter season in some region to the south where reconnaissance work might reasonably be expected to proceed without interruption, either climatic or political.

The most attractive locality appeared to be the famous Yangtze River Gorges, some 1200 miles inland from the Pacific shore, or, more precisely, in the border region of the Hupeh and Szechwan provinces and actually near the geographic center of China. The picturesque chasms had been traversed by Doctor Granger a number of times in going to and fro from his Pleistocene fossil site above Wanhsien and his reports of numerous caves and rock shelters all along that section of the river and above, as well as suggestive indications of archæological remains in his own fossil pits of the hinterland, furnished all the encouragement necessary. These prospects seemed to hold the possibility of another Castillo cavern, containing perhaps the whole story of the Old Man of Asia.

THE EXPEDITION UNDER WAY

Our Yangtze Expedition, under escort of Doctor Granger, left Peking on November 6, 1925. After a thirty-six hour journey by train to Hankow

PLATE CXXV.

A. EXPEDITION JUNK AT ENTRANCE TO THE ICHANG GORGE.

B. JUNKS SAILING UP THE YANGTZE AT SUNSET.

C. EXPEDITION JUNK LYING OPPOSITE THE WALLED TOWN OF KWEI-CHOU.

D. CREW OF THE EXPEDITION JUNK AND THE LANDING PLANK.

PLATE CXXVI.

A. THE WALLED TOWN OF KWEI-CHOU FROM A RIVER STEAMER.

B. OUR BOAT AT THE UPPER ENTRANCE OF WUSHAN GORGE.

C. STEPPING STONES ACROSS A TRIBUTARY STREAM OF THE YANGTZE.

D. WOMEN WASHING CLOTHES AT WANHSIEN LANDING.

and several interesting days and nights on a river steamer, we arrived November 15 off the treaty port of Ichang, at the lower end of the Yangtze Gorges Here temporary quarters were engaged and some local reconnoitering was undertaken. Traces of Neolithic man were found in a rock shelter at the base of the striking pyramidal bluffs directly across the river from the city.

As a further preliminary to serious reconnaissance work, the major Gorges were superficially inspected as far as Kueifu from one of the small steamers which ply the somewhat dangerous waters of the upper Yangtze, with the result that considerable information of practical value was obtained, including a rough topographic chart giving the approximate number and location of the principal caverns later to be examined. Documentary permits were also secured from various civil and military officials, and this under circumstances that were at once strange and delightful, as well as surprisingly expeditious. Imagine being served tea and cigarettes on such occasions and being, for good measure, conducted by the particular functionary himself to the street portal of his yamen! Indeed, so swiftly did preparations go forward that before the end of November, through the helpful assistance of the Rev. J. H. Squire of the China Inland Mission, a native vessel had been chartered and by December 3, 1925, we were off on our problematic cruise.

In order to give our strange outfit a preliminary tryout, we first dropped down the river some fifteen miles to the lower or eastern limits of cliffs and visible caverns. At the small village of Kulowpei, therefore, we really began our slow, uninterrupted two and a half months' exploration through the succession of great gorges and beyond. It ended ultimately without serious incidents at the village of Pai-shui-chih, a few miles above the port of Wanhsien. Here the resumption of military activities compelled us to give up the river survey and we accordingly retired inland to Doctor Granger's camp at Yen-ching-kou, about ten miles up a southern tributary valley. From these landfast headquarters, when weather permitted, joint excursions were made on foot in various directions through the mountainous country, chiefly south and east, covering in particular the Hupeh-Szechwan boundary region. At the end of five weeks, or on March 24, we broke camp and all set out on the long return journey to Peking.

EQUIPMENT AND PERSONNEL

Archæological exploration conducted from a boat, though by no means unique, was to us a new experience. Dictated by necessity and acceded to with some misgivings, we soon discovered its manifold advantages, particularly as regards mobility, comparative independence and, we fancy, even personal security. A brief description of our equipment and personnel may be of interest.

Our vessel, a "ma-yang" in native parlance, was a freighter of 24 tons burden, 68 feet long and 11 feet broad, with a single mast rising amidships about 55 feet. It had a low toboggan-like prow, round bottom, bulging sides (like our whaleback vessels on the Great Lakes), arched roof aft and amidships and a curiously high protruding stern, so constructed to accommodate the excessively broad and shallow rudder with its correspondingly long tiller. To further insure a straight course among the dangerous swirls and eddies to be navigated, an extra-long, stout, oarlike rudder was also, when occasion demanded, attached to the prow, from which it extended directly forward. A long, slightly bent sculling oar was provided on either side, and these, together with a 20 by 40 foot sail, a forwardly-placed capstan and several large coils of bamboo hawsers, completed the essential exterior features of the really handsome craft. For purposes of identification, as well as a measure of safety, we supplied the captain with a serviceable American flag, which he promptly hoisted at half mast; but on our explaining the significance of that position he lost no time in affixing it to a bamboo pole attached to the stern, where it remained through all kinds of weather to the end of the journey.

Below deck the hull was subdivided by watertight cross-partitions into some eight or nine compartments suitable for the storage of liberal quantities of fuel and supplies, as well as for excess equipment and collected specimens. Hidden under an innocent looking heap of stone implements we kept the extra sacks of coin necessary for the long trip between Ichang and Wanhsien, for the smiling captain took no chances on arithmetical calculations but demanded his eight Mexican dollars regularly every evening. The opium den, though not officially sanctioned, took up a forward compartment, and the skipper, in spite of his own bulky supply of fuel and provisions, still found room for a little surreptitious freight.

The navigation of such a vessel on the turbulent upper Yangtze, even in winter when the waters are comparatively low, is a tricky undertaking. It goes without saying, therefore, that the mature professional sailors perform their various tasks with admirable skill and precision. The vessels themselves —junks, sampans and so forth—vary in type from place to place along the mighty waterway and are no doubt the results, like the sailors, of age-long adaptation. They are built largely of whitewood, stained and preserved with a coating of wood oil (of local production), and are therefore extremely light both in weight and in draught, a fact which unquestionably facilitates their apparently easy handling.

Propulsion in our case was effected in a variety of ways: by wind and sail when possible; by the sculling oars; and occasionally by mere poles and hooks. As a rule, however, in going upstream our vessel was simply towed at the

end of a long bamboo hawser by some six to ten members of the crew, who ran, walked, or crawled on all fours, as circumstances required, along the river bank. The number of these trackers had to be increased to a hundred or more (mostly beggars fighting for a chance) whenever we came to ascend one of the more difficult rapids. At the minor rapids we helped ourselves, generally by means of the capstan. Occasionally, when the hawser fouled on a projecting rock out in the stream, some one of the younger members of the crew cheerfully stripped and swam out to effect the release; and when, as might happen at any hour of night or day, a steamer passed while we were at anchor, all hands had to man the poles to prevent the swell from dashing our frail craft to pieces on the rocks. In return for all this strenuous daily work the captain-owner allowed his men to sleep on the forward deck and supplied them twice a day with a generous portion of savorless boiled rice, beans, or cracked maize, spiced a trifle with pickled turnip tops and washed down with a bowl of tea. In the bargain, he was said to be legally obliged to pay each ordinary sailor a whole Mexican dollar a month. Nevertheless, he never ceased complaining of our contract and tried several times, when he thought he had the upper hand or I had shown some signs of generosity, to get his own pay raised on the plea of the high cost of living.

Such in brief were our unique and surprisingly adequate expedition facilities. From the point of view of mere comfort and convenience we had never at home or abroad enjoyed the like field accommodations. With the outfit went a permanent staff and crew of twenty-one people, all housed in more or less segregated quarters above deck. There was Mrs. Nelson in the double capacity of purser and quartermaster, a young interpreter just out of the Mission School and not very robust, a personal assistant for the cave work, a head boy, a cook, and, of course, the captain with his crew, including a small but lusty cabin boy (much admired by the quartermaster, if not the purser) who performed every kind of service up to the honorable task of lighting the skipper's long pipe. Lastly, there was the commander, who, while a little dubious and apprehensive, had unexpectedly realized an almost forgotten youthful ambition instilled in him by others because of a nickname relating him to a certain famous English admiral.

As for the jolly life on board and the distinctly serious aspect ashore, the continually changing rugged scenery, the walled towns, the pagodas, the temples with their images requiring constant sacrifices from all men in ships, the goose-stepping soldiers being drilled on the sandy river banks, the seemingly careless rifle shooters, freely using the passing steamers as targets and occasionally killing somebody, and above all the ever expected "bandits," whom possibly we never saw—these are the jumbled items of what now seems like a strange dream, to be mentioned only in passing.

WORK WITHIN THE GORGES

The survey work itself was in the main very simple. On its way through the Gorges the Yangtze cuts across a succession of more or less folded and repeated geological formations, including conglomerate, sandstone, limestone, shale and granite. The most conspicuous of these is the limestone, which rises to heights of three or four thousand feet and constitutes the partially sheer walls of all the five or six distinguishable Gorges and their several tributaries. As would be expected, the limestone also provides most of the real caves, which pit its surfaces from below the high-water level almost to the summits of visible relief; but the sandstones, the conglomerates and even the shales furnish a considerable number of generally modest shelters suitable for habitation. Our chief task consisted in trying to see the entire environmental setting from the point of view of an imaginary primitive man; to guess which of the caves and shelters he would most likely have occupied since we couldn't visit all; to climb to those selected; and, finally, to test their floor deposits for chance inclusions of cultural or skeletal remains, as well as to examine the walls for possible pictorial inscriptions.

Hunting caves in this way was an exhilarating and even a fascinating form of activity, but it very soon grew a trifle discouraging. From the start nothing really worth the name *prehistoric* turned up and before long it became tolerably clear that nothing much was to be expected. Nevertheless, the investigation went on as before, with reasonable thoroughness, in order to make the negative conclusions as certain as possible. In the end, after scanning more than two hundred miles of the Yangtze trough proper and traversing in more hasty fashion a similar distance in the back country, mainly to the south of the river, we were in possession of only the faintest suggestions that prehistoric man had ever been near the caves! This will seem all the more astonishing when it is stated, first, that a Late Stone Age man had left a fair sprinkling of his works both in the cultivated fields (dwelling sites) and on the river banks (workshops) and, second, that a large proportion of the caves and shelters investigated proved to be, or recently to have been, occupied by the Chinese.

This fact of modern occupation was at first regarded as a serious obstacle to the completeness of our survey. It turned out the opposite, for very often the occupied caves and shelters had been subjected to more or less excavating, done for a variety of purposes. Sometimes the clay floor deposit had been removed for use as soil to cover the small agricultural terraces built up of rocks on the adjacent steep slope; at other places it had been dug up and leached for its nitrous properties; and elsewhere it had obviously been cleared away for no other reason than to make room. The result was that whenever the earthen content of a given cave was not all spread on the artificial terraces

below, where it revealed its sterility at a glance, we commonly found within the cave a prepared section of the floor débris anywhere from one to twenty feet in thickness, awaiting our inspection. This meant a vast amount of time and labor saved for the Expedition, which in consequence was able to proceed with greater speed and yet with full assurance that no likely chance had been overlooked. In short, the Expedition is beholden in a variety of ways to the kindly and industrious modern cave dwellers of Szechwan.

THE DISCOVERY OF NEOLITHIC CULTURE SITES

The extent of our exploration may be summed up briefly as follows: we navigated the Yangtze for a distance of a little more than 230 statute miles and made excursions on foot up various of the tributary valleys and into the back country totaling at least an equal distance. This, it will be understood, was in addition to the ordinary daily task of climbing about from cave to cave facing directly on the river. Of major landings, that is, such stops as involved actual examination of shore features, there were recorded, in all, 122; and the greater number of these were confined to the fifty-mile stretch comprising the Gorges proper. By way of accomplishment, we examined 367 caves and shelters, of which 139, or 38 per cent, were, or had lately been, inhabited. Notice was taken also of the presence and position of 316 additional caves and shelters, many of which likewise gave proof of modern occupation. The results, so far as evidence of Palæolithic man was concerned, proved, contrary to lingering expectation, absolutely negative; and of Neolithic man, we obtained in the caves only faint traces.

The investigation was not, however, confined entirely to the caves. At the very start of our cruise we discovered on the left bank, at the village of Kulowpei, what had been either a workshop or a settlement of Neolithic date. Most probably it was a village and quite likely the direct ancestor of Kulowpei itself. Coming upon the place at the low-water season, we found, at the base of a nearly thirty-foot bluff, a gently sloping foreshore, about 100 yards wide and 600 yards long, literally strewn with worked stone implements, such as hammers, grinders, axes, chisels, hoes and scrapers, as well as broken pottery. The prehistoric relics, unfortunately, were largely mixed with brickbats and débris of all kinds from the present settlement on the bluff above; so that while we were able easily to gather about 150 genuine old axes, we could not distinguish in all cases the ancient and the modern pottery.

This Kulowpei discovery became a clue as to what sort of archæological remains might reasonably be expected all the way up the river; and we at no time neglected it. The result was that we observed and collected remains of this culture at numerous points from the beginning to the end of our river cruise. Most of our finds, as already stated, were made on the surface, either

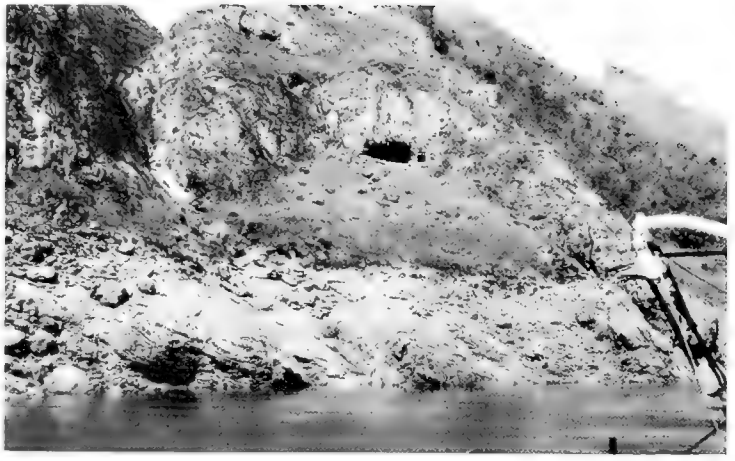
along the river banks or above in the adjacent fields. Two undisturbed deposits of real culture-bearing débris were discovered which gave us a partially correct idea of what traits belonged to the true Neolithic inventory. One of these accumulations filled a small rock cavity (too small for habitation) which we excavated and which proved stone tools and wheelmade pottery to have been, in part, contemporary. The other site was an open-air deposit exposed by a gully and revealing a thickness of nearly eighteen feet. Composed mainly of clay wash from the hills above, this section was nevertheless noticeably stratified, showing throughout streaks and lenses heavily charged with ashes and charcoal, fish and animal bones, traces of human bone, as well as considerable amounts of worked stone and broken pottery. Though the great mass of refuse seemingly implied a considerable time duration, unfortunately there were no appreciable changes from bottom to top in the character of the artifact materials such as might have been expected. This view is, however, subject to modification because, with a farmhouse standing on top of the site, we had to be satisfied with merely a superficial investigation.

CONCLUSIONS DRAWN

These archæological finds, it must be emphasized, were all made on or very near the Yangtze River. Search in the back country to the south produced nothing decisive. It is true that we have the two artifacts brought out by Doctor Granger; likewise that in three places I picked up on the surface single fragments of foreign rock material bearing evidence of human workmanship. But over against these doubtful and alleged discoveries may be cited the fruitless examination, first, of miles upon miles of cultivated fields and minor stream banks; second, of a respectable number of caves and rock shelters; and, third, of the débris hoisted out of more than one hundred of the Pleistocene fossil pits. The indications all favor the view that Neolithic man, who certainly inhabited the Yangtze valley proper, was such a late comer that he did not have time to penetrate, at any rate, certain parts of the hinterland before he was overtaken by his metal-using successor, presumably the Chinese of early historic times. In other words, it would appear that the forest-clearing process begun with stone axes in late prehistoric times, perhaps three to four thousand years ago, is the process still being carried forward by the present agricultural population.

It would take too long here to explain adequately the scarcity of prehistoric remains in the Yangtze gorge country. There are, however, plausible reasons enough, such as the comparative ruggedness and impenetrability of the country, the scarcity of game, and above all the nearly complete absence of flint and other rock substances especially suitable for the production of sharp-edged tools and weapons. Such simple tools as were actually found were all

PLATE CXXVII.



A. NATURAL AND MANTZE CAVES—WUSHAN GORGE.

B. AN OCCUPIED CAVE JUST ABOVE WANHSIEN.

C. VILLAGE OF KULOWPEI, BELOW ICHANG.
In the foreground is a stretch of the shingle beach which yielded artifacts.

D. SAMPLES OF THE ARTIFACTS FROM THE SHINGLE BEACH SHOWN AT THE LEFT (C).

A. CAVE AND COFFIN CLEFT IN THE WIND BOX GORGE.
The trackers' path is seen cut out of the cliff.

B. GROUP OF ARTIFICIAL CAVES AT FAIRY BRIDGE, FU-TOW-CHANG.

C. FORTRESS AT BASE OF SANDSTONE CLIFF NEAR YEN-CHING-KOU.

D. NEOLITHIC SITE AT TAI-CHIH.
The artifacts were found in the cultivated field.

made of common river boulders brought down by tributary streams from the mountainous back country. Caverns, as such, were no special attraction to primitive hunters at any time or place except during extremes of cold,—and Szechwan is semi-tropical. Even Neolithic man in these parts preferred shelters of his own construction, and it is only in recent centuries, perhaps owing to the increasing scarcity of timber, that the Chinese farmers and fisher-folk have taken to the caves.

The results of this Central Asiatic Expedition survey of the Yangtze River Gorges, while in one sense disappointing, are nevertheless both interesting and illuminating. Being first reports on the locality, they are naturally of prime importance for archæological science. They show that prehistoric man played a very inconspicuous rôle in this territory, that he was not a cave dweller, not a hunter, but a woodsman and agriculturist, and that he arrived upon the scene, probably by boat, at a time not long prior to the introduction of the potter's wheel. They suggest, moreover, that Palæolithic man, the true hunter, either never reached the heart of China, or else that the forbidding character of the environment kept him out of this particular region. Of these two alternatives the second is, of course, the only safe one to embrace for the present; for not until the reconnaissance has been carried farther west, well up into the Tibetan highlands, can we safely exclude Palæolithic man from this section of central Asia.

PART III

SUMMARY STATEMENTS

PART III

SUMMARY STATEMENTS

CHAPTER LI

A REVIEW OF THE WORK OF THE CENTRAL ASIATIC EXPEDITIONS

By Chester A. Reeds

INTRODUCTION

In the preceding fifty chapters of this volume, Messrs. Andrews, Granger, Nelson and Pope have presented in narrative form an account of the explorations of the Central Asiatic Expeditions of the American Museum of Natural History in Mongolia and China during the eventful years 1921 to 1930 inclusive. The results achieved have been so monumental that it seems fitting in this chapter to review briefly the work already accomplished, and in the concluding Chapter, LII, to state anew the problems of the field as they appear in the light of present-day knowledge.

EXPLORATION IN MONGOLIA AND CHINA

The Central Asiatic Expeditions were organized primarily for exploration in Mongolia, and although ten years of effort have been considered in the preceding chapters, only five seasons were actually spent in the field, namely: those of 1922, 1923, 1925, 1928 and 1930. The routes of these five Expeditions are shown on the Route Map at the end of this volume. Explorations in Mongolia during the years 1924, 1926, 1927 and 1929 were prevented by the disturbed political conditions and civil wars in China.

In Part I of this volume, comprising Chapters I–XLIII, Doctor Roy Chapman Andrews reveals how the Expeditions to Mongolia were organized and conducted. Aided throughout by well selected and closely coöperating field staffs, he presents in a striking manner not only the day to day observations and discoveries in the field, but also the experiences along the trail, the problems of motor car and camel, the native peoples, their customs and religion, and his dealings with Chinese and Mongolian officials. The amount of territory traversed each day was tenfold greater than that covered by previous explorers in Mongolia. This was due to the introduction and use during each season of a fleet of motor cars supplemented by a supporting

caravan. The territory, although for the most part a desert, proved to contain much of scientific interest in the fields of mammalogy, ornithology, geology, palæontology, botany, palæobotany and archæology. This fact, coupled with the prompt publication of the Expeditions' discoveries by the staff and a corps of coöperating scientists at home and abroad, led to the immediate recognition of the scientific importance of the exploration in Mongolia.

Mongolia being too cold for field work during the winter months, various members of the Expeditions' staff availed themselves of the opportunity to make collections of natural history objects in different parts of China. As noted in Part II, Chapters XLIV to L, the winter seasons of 1921 to 1927 were devoted to this work. In September, 1921, Dr. R. C. Andrews hunted takin in the Taipai Shan of southern Shensi. Mr. C. H. Pope, who spent practically all of his time in China, made large herpetological collections from northern and central China, 1921–1922; the Island of Hainan, 1922–1923; and from Fukien and Kiangsi provinces, 1925–1926. Dr. Walter Granger for three winter seasons, 1921–1926, examined the fossil pits at Yen-ching-kou, in eastern Szechwan, where he collected vertebrate fossils. During the winter of 1925–1926, Mr. Nelson studied the exposures in the Yangtze River Gorges for artifacts and found evidences of a Neolithic culture. During the winter of 1926–1927, Messrs. Granger and Nelson went to Yunnan, where they explored various districts for palæontological and archæological specimens.

PRELIMINARY AND FINAL REPORTS

The territory traversed by these various expeditions in Mongolia and China was so vast, the collections acquired so great and unusual, that it is fitting that the results obtained are being embodied in preliminary as well as final reports. Already 114 scientific papers on central Asiatic subjects have been published in the American Museum *Novitates* and *Bulletin*. Ninety-six of these publications have been bound together and issued as Volumes I and II of the Preliminary Reports. Other papers of a like nature will be prepared and published just as soon as the laboratory studies now in progress shall have been completed.

Twelve quarto volumes have been outlined for the final reports. To date three volumes of this series, known as *The Natural History of Central Asia*, have been published, namely: Volume I, "The New Conquest of Central Asia," by R. C. Andrews, 1932; Volume II, "The Geology of Mongolia," by C. P. Berkey and F. K. Morris, 1927; Volume IV, "The Permian of Mongolia," by A. W. Grabau, 1931. As noted in this volume, page 625, and on the jacket cover of this copy, other volumes of the series are in preparation and will be issued as soon as the manuscripts have been completed and printed.

THE GEOGRAPHICAL FEATURES OF MONGOLIA

The Expeditions observed that Mongolia is a vast interior country of central Asia, and that it covers more than a million square miles. It is bounded by the Arctic divide (Siberia) on the north, the great wall of China on the south, and extends east and west from near the 82d to the 120th meridians. It is divided into two very distinct cultural and political entities, Inner Mongolia, nominally suzerain to China, and Outer Mongolia, a republic, which remains closely affiliated with the Russian Soviet Federation. The parts of Mongolia which were traversed by the Central Asiatic Expeditions lie between the 40th and 46th parallels and the 98th and 114th meridians, east from Greenwich.

Physically speaking, Mongolia is essentially a great plateau-like basin bordered by mountains which rise 5,000 to 12,000 feet above sea-level. On the northwest the plateau-basin is bounded by the extensive mountain complex of the Tannu Ola, Sayan, Khangai and Altai ranges, and on the northeast by the Kentei Shan, Yablonovi Mountains and Transbaikalian highlands. On the southeast it is bordered by the Khingan mountains, a pronounced belt of fault scarps, which separate the plateau-basin from the valleys of Manchuria, and the low plain of north China. On the southeast it abuts against the lofty Richthofen and Nan Shan ranges of the Tibetan plateau. On the west the Mongolian plateau sinks to low levels in the Dzungarian depression and Tarim basin, which lie on either side of the Tien Shan massif.

The Expeditions' geologists discovered that the entire Mongolian Plateau is warped into a gently sloping basin or broad syncline, whose central portion is 3000 feet lower than the outer margins. The greater portion of this central depression is a rock-strewn desert and is known as the Gobi. It is the most uniform part of the plateau and occupies an elongated area 600 miles from north to south and 1000 miles from east to west. The altitude varies from 3000 feet in the east to about 5000 in the south and west. The more open eastern portion between Kalgan and Urga was developed by warping while in the west between the Khangai and Altai mountains the structure is the result of both warping and extensive faulting.

In the Gobi region there are many minor basins without outlets known as talas, such as the Dalai Nor, the Iren, the Gashuin Nor or Edsin Gol, the Kisin or Shargin, the Khara and Dzapkhin or Kirghiz Nor, each occupied by lakes or salt pans. The Expeditions' geologists have noted that each tala has its own local interior drainage and is bounded by inconspicuous warped divides or by mountain ranges, or both, separating it from neighboring areas of similar habit. Again within each tala there are still smaller basins, which contain sediments of late Mesozoic or Tertiary age, or both. These smaller units appear as broad level spaces. Their surfaces are beveled by the Gobi

erosion plane, that remarkably smooth flat surface which is one of the most striking features of Mongolia. These basins of the third order of magnitude, called "gobis," are units of special interest in that it is in them that the fossiliferous localities were discovered. The geologists note two types of gobi basins: first, the faulted or piedmont type, found along the north edge of the fault-block mountains of the Altai; and second, the warped or plains type, in the less disturbed areas. The basins are not all of the same geologic age, and this has led to the finding of fossils of different ages in separate areas in various parts of Mongolia.

The Gobi is for the most part a rock desert. The actual waterless portion, including the Ordos country in the northward bend of the Hwango Ho and the Ala Shan, is confined to the southwestern portion of the plateau-basin and covers barely one quarter of its whole area. Within the Gobi there are remains of ancient drainage courses such as the Ongin Gol, Shara Murun, Lybaghrin Gol, Aboukar Gol and numerous small evanescent lakes and salt pans. Oases occur, but the long cold winters and sparse rainfall make them rather infertile, except for carpets of green grass.

Although the surface of the desert is usually dry and parched, underground water is found in the gravelly-sandy stream-beds and in those depressions where the dip of the strata directs the underground drainage. The water-level occurs at depths varying from a few feet to 12–15 feet. The presence of wells 10 to 40 miles apart along the caravan routes makes it possible to travel in Mongolia. The well water is not always palatable, since there are alkaline waters in many of the basins. At Arishan, where hot water having a temperature of 127° F. issues from the ground, the Expeditions' geologists have located a fault, and consequently these sacred springs belong to the class known as fault springs.

Intermediate between the bordering mountains and the central Gobi desert area there is a belt of grasslands 100 to 150 miles wide referred to as the southern, northern and western grasslands in this volume. Along the Kalgan-Urga trail the grasslands extend from Wan Ch'uan Pass to P'ang Kiang, a distance of 150 miles, then the desert begins and continues to 40 miles beyond Mt. Tuerin, where the northern grasslands start and extend to Urga. The Expeditions also noted extensive grassland areas along the Tola River, in the vicinity of Tsetsenwang, and in the gobis along the northern border of the Altai and Gurbun Saikhan mountains, and extending eastward towards Kalgan. These grasslands, which afford grazing for many thousands of wild animals, are also utilized by the nomadic Mongols for pasturing their herds of sheep, cattle and horses. For approximately 100 miles out from Kalgan along the Kalgan-Urga trail, the Expeditions noted that Chinese farmers are converting these grasslands into grain fields.

WEATHER CHANGES IN MONGOLIA AND CHINA

The present climate of Mongolia is characterized by a remarkably clear cold winter and a hot summer, which is the chief rainy season. During the winter, Mongolia and the Baikal region of Siberia are occupied by a vast high pressure area, referred to as a "center of action" or anticyclone, with the highest known pressure of 1072 millibars at Irkutsk on December 20, 1896. The intensity of the anticyclone is due for the most part to the severity of the cold, forming a great dome-like mass of cold air, but the basin-like topography of the Baikal region and that of Mongolia is also an important factor, for these depressions prevent the cold air from flowing away, hence, the center of the anticyclone is found in the vicinity of Urga, Mongolia, instead of at the "cold pole" near Verkhoyansk, Siberia, where in January, 1886, a temperature of −88.8° F. was recorded. The average January temperature, 1881–1920, at Irkutsk was −4.72° F., with extremes of −15.52° F. From Urga the axis of this high pressure area extends southwestward toward the Black Sea and northeastward toward Bering Strait. To the north of this axis in Siberia, the winds tend to be westerly, but to the south in Mongolia, they are easterly. Along the axis, winds are generally light, but violent blizzards termed "poorgas" and "burans" occur, often causing loss of life. The anticyclone over Mongolia lasts from September to April inclusive.

During the summer months, June, July and August, the vast anticyclone over Mongolia is replaced by a cyclone or large shallow area of low pressure centered over Tibet and east central Asia. The southeasterly winds, which then prevail over eastern Siberia, northern China and Inner Mongolia, bring much cloud and a moderate rainfall. Due to this complete seasonal change in the character of the barometric pressure, the northern interior of China has a regular alternation of monsoons, the cold dry northerly monsoon of winter, and the warm moist southerly monsoon of summer, which is almost everywhere the rainy season. Mongolia and the western and northwestern parts of China have a marked continental climate, with a small rainfall and great extremes of temperature. The rainfall varies from less than 5 inches a year over the Tarim basin and the Gobi desert to over 80 inches along the south coast of China.

As Doctor Andrews has stated in this volume, page 17, the temperature in Mongolia during the winter drops to 40° or 50° below zero. These temperature changes are accompanied by terrific Arctic gales and snowstorms with the snow accumulating in drifts across the caravan trails. Effective field work in Mongolia can be done only between April 1 and October 1. About the middle of April there is a fortnight of delightful weather with warm sun and little wind, which is called the "False Spring." These conditions were noted at Tuerin, April 15–30, 1922, and at "Chimney Butte," April 24, 1928.

The spell of bad weather, May 1 to June 15, which follows the period of the "False Spring," is usually characterized by cold with terrific windstorms, sandstorms and occasional snowstorms. The Expeditions met with such conditions at Tuerin, April 28, 1922, at Irdin Manha, May 19, 1923, at Ula Usu, June 13, 1923, at Shabarakh Usu, May 11–16, 1925, "Flaming Cliffs" to Urga, May 24, 1925, at Tsagan Nor, June 10, 1925, at "Chimney Butte," April 24, 1928, at Shara Murun, May 12, 1928, at Shirigi-in-Sumu, May 29, 1928, at Hatt-in-Sumu, June 11, 1928, and at Wolf Camp, June 23, 1930.

As for summer weather, Doctor Andrews states on page 17 that about the middle of June the real heat of summer begins and continues during July and August with temperatures as high as 110°F. in the shade and 145°F. in the sun at midday. The nights are always cool, sometimes cold, and sleeping-bags are generally welcome. During the day the sun almost always shines. Rain is very infrequent in the Gobi; in the belt of grasslands north and south of the desert there is considerable torrential rain during late July and August.

Autumn conditions in Mongolia during late August and in early September were commented upon by Doctor Andrews as the 1922 Expedition was leaving Artsa Bogdo Mountain September 1. He says: "Nowhere in the world have I known air so invigorating as that of Mongolia in the autumn. The altitude, nearly 5000 feet, and the desert dryness make even the warmest days of summer bearable; the really hot weather lasts only about a month. The final two weeks of August and the first part of September bring an autumn sharpness, which is as delightful as it is stimulating. Our bodies surged with vigor and the most strenuous work seemed not to tire us. It is easy to believe that the proper theater of evolution for the human race must have been on uplands with summer climate similar to that of the present day Mongolia, rather than in the tropics with their debilitating heat."

The Expeditions' foretaste of the early approach of winter is referred to on page 171, when in the early morning of September 13, 1922, at Ardyn Obo it began to rain and the temperature dropped from 78° to 48°F. in a few hours. This sudden change in temperature was followed during the next week by cold and bitter winds with rain and snow as the 1922 Expedition fought the inclement weather on its way back to Kalgan. During the late spring and early winter, storms make motor travel well-nigh impossible, for snow not only obscures the trail, but, the ground being warm, the snow melts after a few days, leaving the ground soft. The terrain has hardly dried before another blizzard arrives. Later in the winter when the ground is frozen, cars can run over it, for the dry snow is swept from much of the desert.

In the course of five seasons' work it was observed that the weather varies from year to year. For instance, at Ula Usu in June, 1923, Doctor Andrews remarks, page 202, that the desert was very dry, as no rain had fallen within

ten months. There was not enough moisture in the ground to bind the sand together, and, consequently, the increasing gusts of wind carried sand into the Expedition's camp. The summers of 1924 and 1930, however, were noted for the unusual amount of rain and floods. As stated by Doctor Andrews, page 233, during August, 1924, Kalgan was partly destroyed by a flood, the bridge was carried away and all the business section flooded, and the streets were covered by hundreds of thousands of tons of loess brought down by the river, which flows through the center of town. The unusual rain induced a wonderful growth of vegetation in the grasslands, and even the Gobi was so clothed with green sagebrush that it hardly resembled the normally grim desert of other years.

TOPOGRAPHIC SURVEYS

On entering Mongolia from Kalgan, the Expeditions found that it was necessary to construct maps, in order to plot accurately the routes followed, the extent and boundaries of the various topographic and geologic formations encountered, as well as the location of the sites of discoveries in zoölogy, botany, palæontology and archæology. Prior to entering the field, copies of existing maps were secured, but after passing Kalgan it was found that these maps were inaccurate and could not be used. Consequently certain members of the staffs of each of the five Expeditions were detailed to make maps of the routes traversed.

For the 1922 and 1923 Expeditions, Berkey and Morris, the geologists, prepared route maps showing the extent of the territory traversed, also six topographic and geological maps of areas where the Expeditions stopped for a week or more. With the aid of an alidade, aneroid barometers and other improvised equipment, a profile line beginning at Kalgan was run as the Expeditions progressed from day to day. On this line were noted the relief and geologic structures for more than 5000 miles. The profiles and six special maps appear in Volume II, this series.

The 1925 and 1928 Expeditions included in their scientific staffs men who were specially trained to construct topographic maps. Thus the 1925 and 1928 routes have been surveyed and the maps published. The 1925 and 1928 surveys have been issued in three forms, designated as follows:

1. Sheets, topographic, scale 1/200,000, numbered 1–29.
2. Exhibits, route outlines, various scales, some 1/160,000, 1/400,000, numbered 1–7.
3. Plates, topographic, scale 1/20,000, lettered A–G.

The 1930 Expedition, which confined its attention primarily to the col-

lecting of fossil vertebrate bones in eastern Inner Mongolia, also surveyed two areas topographically. The maps are in preparation.

These maps of the various Expeditions are in a sense reconnaissance maps. There was not sufficient time nor authorization to make complete surveys. Except for certain small areas, only the routes traversed and the territory adjacent were surveyed. These maps, however, are valid for what they show and represent a beginning in the right direction. All these maps, including both the topographic and geologic maps and explanatory text, are scheduled to appear in bound form in Volume V, this series.

ROCK FORMATIONS IN THE GOBI REGION

The geological and structural elements in the rocks of the Gobi region were set forth by Berkey and Morris in a series of three short papers in 1924, and in a more extended manner in Volume II of this series, 1927.

As now understood there are two major divisions of rock formations in the Gobi region, one known as the "later sediments" of post-Jurassic age, which includes all of those beds which lie nearly flat and rest in the shallow "gobi" basins. The other division, known as the "oldrock floor," extends beneath the "later sediments" and outcrops over extensive areas. It is composed of a series of complex rock formations, which have undergone great deformation and internal modification. Wherever these pre-Cretaceous rocks occur they are folded, are often cut by igneous intrusives and are metamorphosed to a marked degree. In places where these two markedly different types of rocks appear in contact, a great unconformity is found between them, indicating a lapse of time sufficiently great for mountain folding and uplift to have taken place and to have been followed by periods of erosion of sufficient duration to remove thousands of feet of material before the first basin sediments were deposited. These two major divisions of rock formation appear in marked contrast, the older, pre-Cretaceous series, being characterized by mountain folding and deformation, the younger, post-Jurassic beds, by warping and block-faulting without mountain folding.

THE OLDROCK COMPLEX

The accompanying generalized columnar section, Fig. 10, of the oldrock floor prepared by Berkey and Morris, 1924, summarizes in diagrammatic form the pre-Cretaceous formational history and geologic structure of Mongolia. The section is composed of ancient sedimentary strata, metamorphic rocks and intrusive igneous masses, both large and small. The history involved is long and complex, embracing hundreds of millions of years. One of the most outstanding dynamic events of this period was the invasion of a deep-seated molten magma throughout the length and breadth of Mongolia. It formed

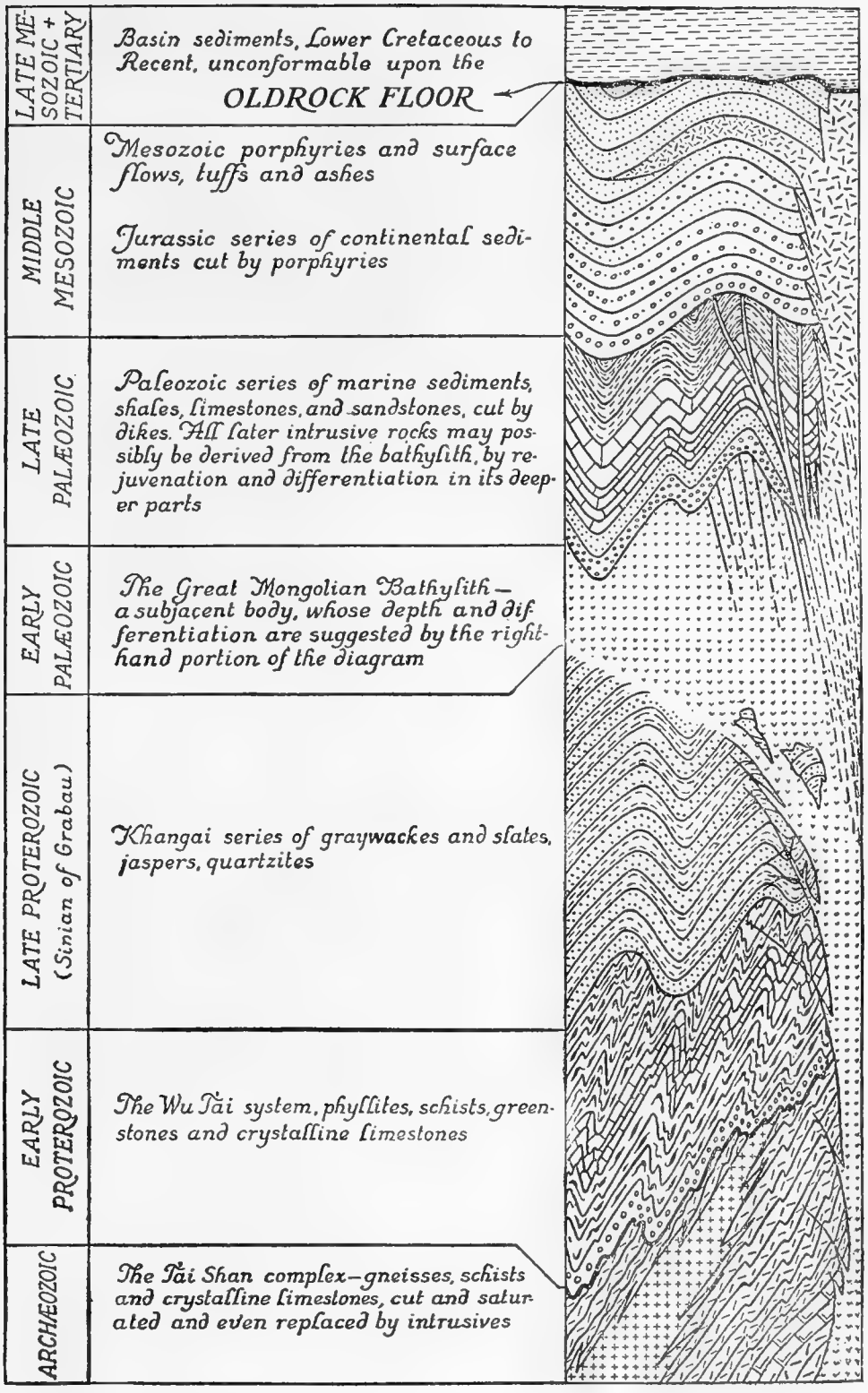


FIGURE 10.—Generalized columnar section of the oldrock floor. From "Geology of Mongolia."

what Berkey and Morris in 1924 called "The Great Mongolian Bathylith." The granitic rocks of this bathylith now widely exposed in Mongolia show considerable variety of composition, but the dominant type is a biotite granite of medium coarse texture and massive structure. At the time it was intruded it affected all the sediments then in existence, including the Khangai graywacke series. A preliminary summary of the geologic history of this ancient crystalline complex appears in Volume II of this series, pages 397 to 415. The fossil fauna of the Jisu Honguer limestone, embracing a considerable portion of the exposed Palæozoic series of marine limestones noted in the column, has been made the subject of Volume IV, "The Permian of Mongolia," by A. W. Grabau.

THE "LATER SEDIMENTS"

As defined by Berkey and Granger in American Museum *Novitates*, No. 77, 1923, the so-called "later sediments" of the Gobi region include all the nearly horizontal strata which have accumulated in the deformed basins since the post-Jurassic peneplanation. They lie above a great unconformity and so are readily distinguished from the deformed and much modified structures of the "oldrock floor." The "later sediments" occur in both the faulted and open plains type of "gobi" basins. In addition to the initial paper of 1923, the "later sediments" were discussed by Berkey and Morris in Volume II, this series, pp. 352–372, 1927. New formational names were added to the list by Berkey, Granger and Morris, American Museum *Novitates*, No. 385, 1929, and by Dr. L. E. Spock, *Novitates*, No. 394, 1929, and *Novitates*, No. 407, 1930.

A columnar section of the known formations of the "younger sediments" appears on the accompanying chart, Fig. 11. Some thirty-nine formations have been defined. They range in age from the Lower Cretaceous to the Recent. It is well to note that their names, thicknesses, character of sediments, chief fossils and deformational history have been but briefly summarized on the chart.

MONGOLIAN EROSION PLANES

In the erosion of the present land surface of Mongolia, Berkey and Morris, American Museum *Novitates*, No. 136, 1924, have outlined four peneplane stages, namely: Khangai, Mongolian, Gobi and P'ang Kiang. The authors state that there is some doubt as to the age relations of the Khangai and Mongolian peneplanes, for the evidence is not conclusive as to whether they are separate and distinct or whether one is the warped surface of the other. The Khangai peneplane was observed in the Khangai Mountains north of the lamasery of Sain Noin Khan. The Mongolian peneplane bevels all the mountainous areas of Mongolia and is a clearly defined ancient erosion surface.

The authors are of the opinion that it probably also represents the mature surface of erosion which passes underneath the Cretaceous sediments and thus separates the older from the younger series of sediments. The Gobi peneplane appears at altitudes lower than the Mongolian peneplane. It affects beveled, tilted and faulted strata and is underlain by sediments of Eocene and Oligocene age. It is believed to be of Middle Pleistocene age. The P'ang Kiang lowland is the term applied to the surface of the numerous undrained hollows which have been carved out of the Gobi peneplane and lie at lower levels. It is believed to be of late Pleistocene age.

CHANGES IN CLIMATE IN MONGOLIA DURING GEOLOGIC PERIODS

"The successive climates of Mongolia" is the title of Chapter XXI, pp. 373–396 of "The Geology of Mongolia." In this chapter Berkey and Morris present much evidence that the climate of Mongolia has changed many times during the course of geological time. For the pre-Cambrian they cite the well-bedded, dark sandstones, gray slates and conglomerates, which comprise the graywacke series of the Khangai Mountains, as having been deposited under a cool or temperate climate with abundance of moisture. For the marine Palæozoic formations of Permian age, which have few corals and none of the reef building types, they infer that the fauna suggests a temperate rather than a tropical climate.

For the lower Jurassic rocks, consisting of conglomerates, sandstones, shales and associated lava flows, tuffs, ash beds and some coal, they infer a series of separate intermontane basins with a continental climate. Weathering and erosion of rock surfaces were long-continued and water was present in sufficient abundance to move the pebbles, wash out the finer sediments and permit the rivers to assort their loads. The single deposit of coal in the Gobi and the more widespread deposits in Siberia and China suggest broad swamps in the old land surface of Jurassic time, with the heaviest rainfall about the margins of the Gobi and in Siberia, Manchuria and China. A warm climate with only a moderate rainfall is inferred for Mongolia during the Jurassic period.

For the Cretaceous period, the Oshih deposits, representing a piedmont alluvial fan, suggest a shifting current in a continental climate. The dark paper-shales without fossils indicate lake deposits, while those with gypsum crystals imply bitter waters of an undrained lake in a semiarid climate. The large insects and aquatic larvæ of the Ondai Sair formation suggest a moderately warm climate. The variegated cross-bedded strata of the Iren Dabasu formation, deposited upon flood plains and in shallow lakes, yield mollusks, trachodont dinosaurs, crocodilians, turtles and fishes, but no plant remains except a few bits of silicified wood. These, together with the angular and

unweathered nature of the sediments, suggest a semiarid rather than a humid climate. The fine red cross-bedded sand of the Djadochta formation and associated dinosaur remains with egg nests indicate wind-blown deposits and sand-dunes of a semiarid climate. Generally speaking, Mongolia during Cretaceous time was semiarid, but more moist than during the following Tertiary period.

For the Tertiary periods, during which time the Himalaya Mountains were uplifted and added to the Asiatic land mass, far-reaching climatic effects were produced. The development of the arc-shaped ranges off the coast of Asia and of the fault-block mountains of central Asia, and the warping of broad areas into high inland basins, also tended to make the climate more continental than it had been during Jurassic and Cretaceous times. There is no evidence of very heavy rainfall in the entire record of the Tertiary, and it is inferred that the climate varied between semiarid and desert conditions during the entire 60,000,000 years of the Cenozoic era.

The Pleistocene, or last million years, witnessed the most variable climate of any of the post-Cretaceous periods. It includes epochs warmer as well as colder than the present. During the cold epochs the higher mountains of Asia bore large alpine glaciers, and portions of Siberia were covered by broad ice caps. Although the Gobi region was not glaciated, glacial cirques containing small glaciers appeared on the higher slopes of the Khangai and Ikhe Bogdo mountains. During these cold epochs moister climates prevailed, and stream erosion increased as well as the number and size of the inland lakes. During the warmer epochs there must have been greater desiccation in the Gobi region than during the cold epochs. Berkey and Morris are of the opinion that Asia was probably lower, warmer and rainier during much of the Pleistocene than at present; and that the period witnessed the growth of mountains and several adjustments of continental level, besides great changes in climate.

For the Recent period, Berkey and Morris note many evidences of climatic change, namely: the building and partial destruction of several successive alluvial fans along the Altai front; the changes in beaches at Tsagan Nor; the redissection of the gently sloping walls of hollows; the renewed dissection of smooth surfaces which formerly supported a richer carpet of vegetation than at present; the carving of broad valleys by streams which have vanished, and whose channels are now filled with wind-blown sand; the failure of rivers to reach their terminal lakes; the shrinkage of the size of meander-curves of rivers; the drying of salt lakes to form salt pans; and the presence of old drawings cut upon rocks by a vanished race, picturing animals that lived in woodlands, though the region is now bare of trees. They conclude that this evidence implies alterations of climate, with a steady swing toward a drier climate in the present day.

FOSSIL FAUNAS AND HORIZONS

The Expeditions' palæontological discoveries in Mongolia have been numerous and of great interest to science. Prior to the Expeditions' entry into the Gobi region, the extinct animals of India, especially the later Tertiary, were well known. In China only those of Pliocene and Pleistocene age were known and they but little, since all information concerning them had been derived from fossil teeth and bones purchased in Chinese drugstores, where they have long been sold as medicine. For Mongolia only a single titanothere bone had been found. The Expeditions' exploration and finding of fossils in the Jisu Honguer limestone of Permian age and in many of the thirty-nine formations of the "younger sediments," Fig. 11, was like discovering a new continent. In fact an old continent new to science, the continent of Gobia as A. W. Grabau calls it, was discovered. The palæogeography of this ancient land throughout the various geological periods is still somewhat obscure, but four maps delimiting its extent have been published by the Geological Survey of China as Plates I–IV, Part I, "Stratigraphy of China," by A. W. Grabau, 1923–1924.

It is now known that for millions of years this continent of Gobia was extremely favorable to the evolution of reptiles, mammals, insects and plants, and probably birds; that it was aboundingly rich in life throughout upper Jurassic, and throughout all Cretaceous and Cenozoic time, and that it was sparsely forested, traversed by streams and rivers, and had a limited seasonal rain-supply, as noted by Professor H. F. Osborn in his paper "Ancient Vertebrate Life of Central Asia," 1930.

During the Permian period, which preceded the evolution of the great land faunas of central Asia, a portion of the land of Gobia was invaded by marine waters, and in an arm of the sea there dwelt an invertebrate fauna which Professor A. W. Grabau has described in Volume IV, this series, 1931. From the fossils which the Expeditions collected from limestone beds at Jisu Honguer, southern Mongolia, Professor Grabau has described an invertebrate fauna which consists largely of brachiopods (99 species and varieties representing 32 genera), a few corals (4 species), bryozoans (2 species), pelecypods (17 species), and gastropods (18 species). Foraminifers and cephalopods were not seen, and echinoderms are known from only a few crinoid stems. All of the known fauna except the spirifers and spiriferellas are dwarfed. In a total of 139 descriptions, one new family of corals, five new genera of brachiopods and one new subgenus of pelecypods are proposed. In addition to these new forms, sixty-five new species, eighteen new varieties and two new mutations are described. The fauna is for the most part of Middle Permian age.

The Expeditions' fossil record for the Mesozoic and Cenozoic eras is no less interesting. Of the 114 Asiatic papers published to date in American

SUMMARY OF MONGOLIAN FORMATIONS, FAUNAS AND GEOLOGIC HISTORY FROM JURASSIC UP

Era	Period	Epoch	Formation	Thickness	Types of sediment	Chief fossils	Igneous activity	Diastrophism
CENOZOIC	QUATERNARY	Recent	Shabarakh	50′	Upper part, dune sands	Upper culture: Pottery, arrow-points, grinders, hearths	None	None
					Lower part, shallow lake deposits clays, sands and minor gravels	Mesolithic culture: hammer-stones, flakes, scrapers, disc-beads Horse, antelope	None	None
		Pleistocene	Orok Nor	5′	Washed gravels of Gobi upland and higher river benches	Primitive stone artifacts	None	None
			Tsagan Nuru	50±	Sands and fine gravels	Struthiolithus, ? Mastodont, Rhinocerid, large Cervid	None	None
			Joselungi	12′	Gobi upland gravels	No fossils	None	None
			Uljitundur	300±	High alluvial fans of the Altai front	No fossils found	None	Slight warping
			Bilik Gol	20±	Sands with interbedded soil	Fragments of artiodactyls	None	None
			Gochu	1000±	Coarse rubbles (on ridges along the Altai front)	Fragment of unidentified bone	None	Faulting and tilting
			Khunuk	130′	Buff sands and clays	Equus, Rhinoceros, Gazella, ? Sarridentinus	None	Slight warping
	TERTIARY	Pliocene	Tung Gur	500±	Variegated clays, sandstones, coarse sands	Amebelodon, Rhinocerid, Canid, etc.	None	None
			P'ang Kiang	300±	Chiefly red clayey sands and light gray gravels	Rodent	None	None
			Hung Kureh	2000±	Yellow and white sands, gray clays	Hipparion, Gazella, etc.	None	Faulting, tilting and minor folding
		Miocene	Loh	100±	Olive green and brown clays and gravels and possibly white sandy beds	Sarridentinus and Baluchitherium	None	Faulting and warping
		Oligocene	Hsanda Gol	300±	Red clays and sands, light yellow sands, with gravels, rubbles and tuffs below	Baluchitherium; large microfauna.	Basalt flows	Faulting and warping
			Jiriigo: Hsanda Gol extension in Khunuk Valley	200±	Red sands and clays, gray sands	Baluchitherium fauna	Basalt flows	Warping
			Houldjin	40′	Yellow gravels and sands	Baluchitherium and Entelodon	None	None
			Baron Sog	30′	White and drab sands and clays	Largest Titanotheres and Baluchitherium	None	None
			Elegen	160±	White arkoses and brown clays	Titanothere	None	Warping
			Ardyn Obo	500′	Yellow sands and gravels above, gray and red clays below	Caduceatherium fauna	None	None
			Ulan Gochu	200±	Red clays and white sandstones	Titanotheres with elongate, clubbed nasals (Embolotherium)	None	None
		Eocene	Shara Murun	200±	White gravels and sands above, Brown, red and greenish clays below	Protitanotherium mongoliense fauna	None	None
			Tukhum	150±	Hard red clay under Shara Murun	Teilhardia	None	None
			Ulan Shireh	150±	Red clays with minor gray and yellow beds	Chalicotheres and Titanotheres	None	None
			Irdin Manha	100±	Gray to white gravels, sands and clays	Protitanotherium grangeri fauna, Andrewsarchus	None	None
			Kholobolchi	250±	White to rusty and drab gravels sands and clays	Amblypod skulls	None	Warping and faulting
			Arshanto	100±	Hard red clay and lenses of gray sandstone	Schlosseria	None	None
		Paleocene	Gashato	300′	Red and brown clays and gray gravels and sands	Palaeostylops fauna	Basalt flows	Slight warping
UNCONFORMITY: SLIGHT DISTURBANCE WHICH IS MOST MARKED NEAR THE ALTAI RANGES								
MESOZOIC		Upper Cretaceous	Djadochta	500′	Fine red sand and red clay	Protoceratops fauna	None	Slight warping
		Lower Cretaceous	Iren Dabasu	80′	Gray clays, gray sandstones and red clays	Iguanodonts and Struthiomimids	None	Slight warping
			Dohoin Usu	300±	Red clays and sands; gray sandy clays	Iguanodonts, Crocodiles, Turtles, Gastropods		
			Dubshih	1000±	Conglomerates, sandstone, thin Limestone, rhyolitic tuff and ash	Pelecypods and Gastropods		Faulting and tilting
			Ochungchelo	2000±	Basal conglomerate; gray and red clay and sand	Sauropod fragment	None	Faulting and tilting
			Tairum Nor	100′	Red and white clays, ferruginous sandstone and limestone	Small dinosaur and wood		Faulting and tilting
			Baiyling Bologai	150′	Red gravels, sands and clays	Large dinosaurs, indet.	None	Slight warping
			Jasu Jergulung	100±	Paper shales	Estheria	None	None
			Go Yoto	250±	Silts and fine sands (probably aeolian)	None found	None	None
			Shirigu	?	Sands and clays	Fragments of dinosaurs	Basalt flows	Faulting and tilting
			Oshih	2000±	Conglomerates, sands, clays, paper shales and thin limestones	Psittacosaurus, Prodeinodon, Asiatosaurus	Basalt flows; extinct hot springs	Faulting and warping
			On Gong	500±	Sands and clays	Diplodocus-like Sauropod	None	Warping and folding
			Ondai Sair	500±	Sands and paper shales	Protiguanodon, Sauropod and Lycoptera fauna	None	Faulting and tilting
GREAT UNCONFORMITY: ALL FORMATIONS BELOW THIS ARE AT LEAST PARTLY FOLDED AND FORM THE OLD ROCK FLOOR OF THE GOBI REGION								

FIGURE 11.—Summary of Mongolian formations, faunas and geologic history from the Jurassic up. After Osborn.

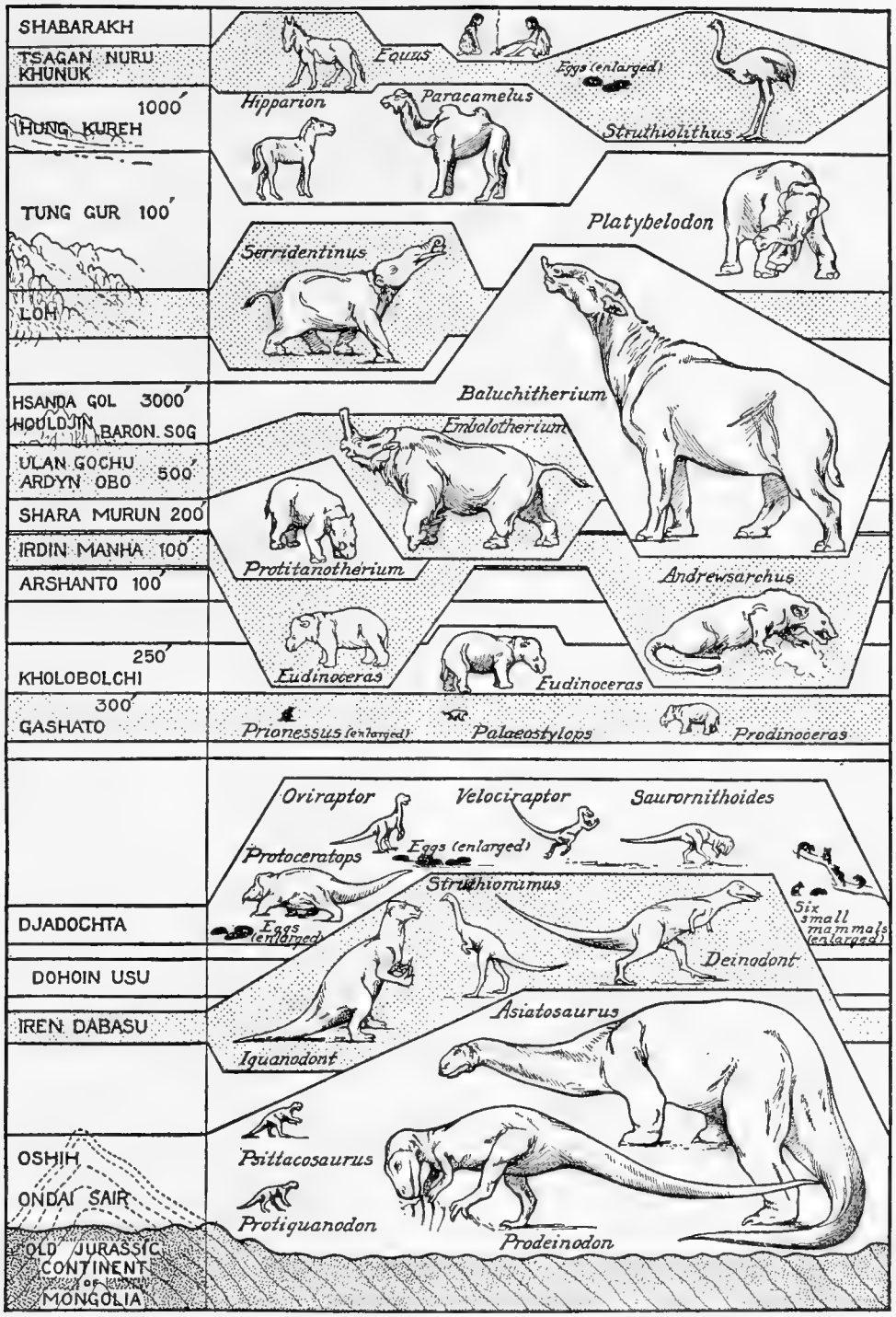


FIGURE 12.—The Later Sediments of Mongolia with some representative forms from each fauna. After Osborn.

Museum *Novitates* and *Bulletin*, it may be noted that 51 of these papers, covering the period May 4, 1923, to August 22, 1932, are devoted to fossil forms. In these fifty-one publications there are listed 218 descriptions of fossils, in which 4 new families, 2 new subfamilies, 64 new genera, 148 new species and 1 new variety are described. This fossil assemblage includes descriptions of the following groups: plants 5, gastropods 2, insects 8, crustaceans 1, fish 6, amphibians 1, turtles 14, crocodilians 2, dinosaurs 13, mammals 166, a total of 218. Doctor Andrews in his narrative, Part I of this volume, gives not only the names of most of these forms, but also the circumstances under which they were found. Although this is a formidable list of new fossil forms, it should be remembered that this is but a portion of the collection, for still other specimens await study and description. The more noteworthy types of the successive continental faunas found in the "later sediments" of Mongolia are illustrated in Fig. 12.

It is interesting to note that of these 51 publications on Asiatic fossils, Professor H. F. Osborn has written 13, Dr. C. C. Mook 2, Dr. G. K. Noble 1, Dr. G. G. Simpson 4, Drs. W. D. Matthew and W. Granger 14, Drs. Matthew, Granger and Simpson 2, Drs. W. K. Gregory and G. G. Simpson 1, Drs. Gregory and Mook 1, Drs. Matthew, Granger and Berkey 1, Professor T. D. A. Cockerell 3, Professor Victor Van Straelen 1, Dr. C. W. Gilmore 1, Dr. L. Hussakof 1, Dr. Chi Pong 1, Dr. R. W. Chaney 1, and Professor Osborn and Dr. Granger 4.

THE LIVING AND FOSSIL FLORA

The botanical collections of the Expeditions were made largely by Dr. Ralph W. Chaney of the 1925 Expedition. On page 315 of this volume he reports that the plant collections comprise 450 to 500 species, of which there are four trees—willow, poplar, birch and elm; about 30 bushes and shrubs, two vines and the remainder herbs. He states that the most abundant families are the grass family with more than twenty species, and the pea family with about thirty species. As to the distribution and uses made of these plants the reader is referred to Doctor Chaney's statement in this volume, pages 315 to 316. In American Museum *Novitates*, No. 79, 1927, one new species of poplar, *Populus pilosa* Rehder from the eastern Altai Mountains, was described. In this publication Doctor Chaney submits a supplementary note on the distribution of the species.

According to Doctor Chaney, the scarcity of trees in the Gobi desert is striking evidence of the low rainfall over this great plateau. The fossil plant material from Mongolia, which is chiefly in the form of petrified tree trunks, bears out this statement. Doctor Chaney in *Natural History*, XXVI, page 532, 1926, stated: "From the small size and twisted stems of many specimens,

it is clear that the fossil forms are related to the trees now living in the semi-arid parts of the world, where conditions are not favorable to tree growth. The more delicate plant structures, leaves and fruits, are for the most part absent from the Cretaceous and Tertiary sediments of Mongolia. The scarcity of such impressions in the sediments of Mongolia suggests that its past climate was too arid for the presence of many permanent water bodies. At the two places where leaf impressions have been found, in the Cretaceous at Ondai Sair and in the Pliocene or Pleistocene beds at Hung Kureh, the plants represented are of aquatic types not greatly unlike some of those living on the borders of Orok Nor to-day."

Three species of fossil plants, *Baiera furcata* (Lindley and Hutton), *Phyllocladites* (?) *morrisi* Cockerell, and *Czekanowskia* sp., from the Ondai Sair formation, Mongolia, have been described by T. D. A. Cockerell in American Museum *Bulletin*, LI, pp. 132, 143–144, 1924. The specimens are fragmentary and are referred with some doubt to the Ginkgoales. They are believed to be of Jurassic age.

One species of fossil hackberry seeds, *Celtis barbouri* Chaney from the Pleistocene loess beds of northern China, has been described in American Museum *Novitates*, No. 283, 1927. Seeds of the same age have been found in deposits in California and in South Dakota. The Chinese seeds are somewhat smaller than the American seeds.

Another analogue between eastern Asia and western United States appears in the form of a fossil redwood forest near Mukden, Manchuria, of Upper Oligocene age, which, according to Doctor Chaney, is similar to the fossil flora at Bridge Creek, Oregon, and to the living redwood forest on the coast of California. The Manchurian fossil redwood, *Sequoia langsdorfii*, is associated with other species of fossil plants, such as alder, oak, maple, sycamore, poplar and fern. Similar fossils have been found at Vladivostok, and it is probable that the forest was continuous along the Asiatic coast during Tertiary time.

THE LIVING FAUNAS OF MONGOLIA AND CHINA

On page 47 of this volume, Doctor Andrews has outlined four faunal zones for Mongolia, namely:

1. The South Mongolian Zone, confined to the southern grasslands.
2. The Gobi Zone of typical desert life.
3. The North Mongolian Zone, confined to the northern grasslands.
4. The Mongolian-Siberian Zone, embracing forested areas in the mountains along the Arctic Divide.

The South Mongolian Zone is characterized by the short-tailed goitered

antelope, *Procapra gutturosa*, which is also found in the northern grasslands; the grassland spermophile, *Citellus dauricus;* and the dark-colored jerboa, *Allactaga mongolica annulata*. Wolves and foxes and the field vole *Microtus warringtoni* are native, but not abundant. The snake *Elaphe dione* has been observed.

The avifauna representatives are the chough, *Pyrrhocorax pyrrhocorax;* the red-legged partridge, *Alectoris græca pubescens*, and the great bustard, *Otis tarda dybowskii*, which although common to the grassy plains is generally distributed over all Mongolia. In the spring, there are great flocks of waterfowl such as bean geese, *Anser fabalis fabalis*, the mallard duck, *Anas platyrhynchos*, the teal, *Anas crecca crecca*, the shoveler, *Spatula clypeata*, the redhead, *Nyroca ferina ferina*, and the tufted bluebill, *Nyroca fuligula*. The more abundant shore birds on the grasslands are the sand plover, *Charadrius leschenaultii*, the little ringed plover, *Charadrius dubius curonicus*, the golden plover, *Charadrius dominicus fulvus*, the lapwing, *Vanellus vanellus*, and the gray-headed lapwing, *Microsarcops cinereus*. The curlew, *Numenius arquata*, the avocet, *Recurvirostra avosetta*, and the snipe, *Capella gallinago raddei*, are fairly common near ponds. The beautiful demoiselle crane, *Anthropoides virgo*, which breeds in northern and central Mongolia, is also common in the wheat fields. The ruddy sheldrake, *Casarca ferruginea*, is omnipresent in the Gobi, while the burrow sheldrake, *Tadorna tadorna*, is common on ponds and lakes.

The Gobi Life Zone is characterized by the long-tailed antelope, *Gazella subgutturosa hillieriana;* the pale-colored jerboa, *Allactaga mongolica;* the three-toed jerboa, *Dipus sowerbyi;* the desert hamster, *Cricetulus migratorius*, the lizards, *Phrynocephalus versicolor* and *Eremias przewalskii*, and the brown pit-viper, *Agkistrodon halys intermedius*. On the desert plains north of the Altai Mountains, the wild ass, *Equus hemionus typicus*, occurs. The desert gazelle and wild ass are often seen together. The hedgehog, *Erinaceus*, the sand rat, *Rhombomys opimus nigrescens*, and a brown shrew, *Crocidura lar*, have been found associated with a desert fauna at Loh in the western Gobi.

The avifauna, which is usually not confined to a single zone, is represented by the sand-grouse, *Syrrhaptes paradoxus*. Kites, golden eagles and the black vulture, *Ægypius monachus*, have also been seen in the desert north of the Altai Mountains, near Loh.

The North Mongolian Zone of grasslands is characterized by the gophers, *Citellus pallidicauda;* the five-toed, long-eared jerboa, *Allactaga mongolica*, which is abundant; the hamsters, *Cricetulus griseus obscurus* and *Cricetiscus campbelli;* the semi-desert hamster, *Cricetulus migratorius curtatus;* the marmot, *Marmota bobak*, is common; the wolf, *Canis lupus laniger*, is present, but not abundant. The same may be said of foxes. The vole, *Microtus brandti*, and

the pica, *Ochotona daurica*, are present. The grassland antelope, *Procapra gutturosa*, is common. Near Sain Noin, spermophiles and gophers are abundant. The large weasel, *Mustela larvata tiarata*, preys upon these rodents. In the grasslands near Canyon Brook, a vole-like mouse, *Microtus* (*Alticola*) *worthingtoni semicanus*, occurs. According to Dr. Glover M. Allen, who has described most of the mammalian forms collected by the Expeditions, it represents a new race closely related to *Alticola worthingtoni* of the Tien Shan. The conies, *Ochotona pallasi*, were also trapped at Canyon Brook. Near Ondai Sair, a pale yellowish mouse, *Lagurus przewalskii*, a jerboa, *Stylodipus andrewsi*, and conies, *Ochotona pallasi*, were caught. Here hares, *Lepus tolai tolai*, were abundant.

The avifauna is represented by the great bustard, *Otis tarda dybowskii*, which breeds in this zone in numbers; the Mongolian lark, *Melanocorypha mongolica;* the demoiselle crane, *Anthropoides virgo;* the rock pigeon inhabits rocks and mountain foothills; the ruddy sheldrake, *Casarca ferruginea*, is common on the marshes of the western Gobi; the great golden eagle, *Aquila chrysaëtos daphnea*, and the steppe eagle, *Aquila nipalensis nipalensis*, are abundant; hawks and the black-eared kite, *Milvus lineatus*, are abundant; the eagle owl, *Bubo bubo kiantschensis*, appears southwest of Urga.

The Mongolian-Siberian Zone, which is characterized by forests of spruce, larch, pine, birch and maple, affords a fauna consisting of roe deer, wapiti, moose, wild boar, musk deer, foxes, sables, squirrels and lynx. The lemming, *Myopus*, the red-backed mice, *Evotomys*, and the voles, *Microtus*, also occur in these northern forests. The avifauna consists of the capercaillie, black grouse, hazel hen and ptarmigan.

Besides the wild life listed for the four Mongolian faunal zones, the Expeditions secured large collections of specimens from China. The Chinese and Mongolian collections, as described in the 114 articles on Asiatic forms appearing in American Museum *Novitates* and *Bulletin*, include 52 publications distributed as follows: 18 papers devoted to mammals, 1 to birds, 23 to Chinese fresh-water fishes and 10 to Chinese reptiles and amphibians. The entries in the 18 papers on mammals include 249 descriptions, 3 new genera, 17 new species and 34 new subspecies. The paper on birds, which deals with a 1916–1917 Asiatic collection, chiefly from Yunnan, contains 295 descriptions, 1 new species and 2 new subspecies. The 23 papers on Chinese fishes include 227 descriptions, 1 new genus, 2 new subgenera, 67 new species, 10 new subspecies, as well as a check list of known species. The 10 papers on reptiles and amphibians include 400 descriptions, 73 new species and 10 new subspecies. The totals in newly described forms of the living Asiatic fauna are: Descriptions 1171, new genera 4, new subgenera 2, new species 158, new subspecies 56.

Of the 18 papers on mammals, Dr. R. C. Andrews has written 1 and Dr.

G. M. Allen 17. The late Outram Bangs wrote the paper on birds. Of the 23 papers on Chinese fresh-water fishes, Dr. H. W. Fowler prepared 3, Mr. J. T. Nichols 19 and J. T. Nichols and C. H. Pope 1; of the 10 papers on reptiles and amphibians, Dr. K. P. Schmidt prepared 3, Mr. C. H. Pope 6, and Messrs. Schmidt and Pope 1.

PREHISTORIC ARCHÆOLOGY

The Expeditions found evidences of prehistoric man but no fossil human bones. Specimens of a fossil man, *Sinanthropus pekinensis* (Black and Zdansky), however, have been recently found in limestone cave deposits at Chou Kou Tien, some twenty-five miles southwest of Peking, China.

The site at Chou Kou Tien was discovered in 1921 by Dr. J. G. Andersson, Mining Adviser of the Geological Survey of China, and Dr. Walter Granger, Chief Palæontologist of the Central Asiatic Expeditions. At the time of their visit some fossil bones and quartz fragments were obtained. Dr. Granger did not follow up this lead for fossil man, however, since an agreement had been entered into between the Geological Survey of China and the Central Asiatic Expeditions that the Expeditions would not enter upon geological, palæontological or archæological explorations in northern China. Consequently, the rich fossiliferous site of Chou Kou Tien was left to Dr. Andersson and his assistant, Dr. O. Zdansky. The place was later surveyed, partially excavated and described by Doctor Zdansky in proceedings of the University of Upsala, Sweden, 1923–1927. Fossil teeth and bones of various mammals, including bats and monkeys, and two hominid teeth, one premolar and one molar, had been found.

In 1927, Dr. Davidson Black, of the Peking Union Medical College, obtained a grant of money from the Rockefeller Foundation and a permit from the Geological Survey of China to resume excavations at Chou Kou Tien. In 1929, in a lower level of the cave an adult *Sinanthropus* skull was discovered by his assistant, W. C. Pei. In 1930, a second *Sinanthropus* skull was found associated with a rhinoceros skull and some artifacts. Evidence of the use of fire was also discovered. These finds were described by Doctor Black in *Palæontologica Sinica*, Series D, VII, fasicle I (1927) and fasicle II (1931), Peking. The specimens were found in the basal lower Quarternary (Pleistocene) of eastern Asia. This fact is of great significance in its bearing upon the problems of human origin and dispersal, for it confirms the soundness of the theory of the central Asiatic origin of primates and man suggested first by H. F. Osborn in 1900, subsequently developed by W. D. Matthew in 1915, and discussed by Davidson Black in 1925.

In Chapter LII of this volume A. W. Grabau suggests that a determined search for Oligocene anthropoids should be made and for "*Proanthropus*," the

most primitive human. He believes that specimens of these forms, as well as *Sinanthropus*, will be found in deposits in Mongolia and Sinkiang. He is also of the opinion that Palæolithic man had his development and radiation along the Pleistocene ice borders in western and northern Siberia.

As Mr. N. C. Nelson says in American Museum *Novitates*, No. 222, 1926, the Gobi Desert probably never offered any outstanding material attractions to primitive men, for the bare necessities of life, such as edible plants, animals, water, fuel and shelter, are lacking. From our present knowledge of the past climate of the Gobi, we may say this condition has prevailed for many long geologic periods. At various places along the southern margin of the desert, however, superficial traces of one or two prehistoric cultures were observed. On the north side of the Altai Mountains, where workable artifact materials such as jasper, chalcedony and agate exist, there were abundant evidences of long-standing human occupation. Here several types of artifacts belonging to a succession of cultural horizons were collected by the Expeditions' staff. Two horizons were differentiated and noted at seven widely distributed localities. These cultures were found imbedded in old stratified wind deposits. At Shabarakh Usu, where a former extensive lake bed with small inflowing stream and wind-blown deposits occur, these cultures were observed in stratigraphic juxtaposition. As identified by Mr. Nelson, five of the six horizons noted are prehistoric in age and are named, beginning with the oldest, as follows: I Eolithic, II Upper Palæolithic, III Mesolithic, IV Neolithic, V Metallic and VI Mongol.

Evidences of the Eolithic and upper Palæolithic cultures were found in the vicinity of Orok Nor. The Mesolithic or Shabarakh culture of pre-Neolithic age was found at Shabarakh Usu. The chipped stones which were found in great number conform closely to the Azilian flint industry of western Europe. The Neolithic culture was found to have a wide geographical range. The Metallic stage is characterized by monumental and pictorial features. The monuments consist of rectangular and circular rock inclosures with dimensions varying from 3 to 150 feet across. Investigations proved most of them to have been burial places. The pictorial features comprise a series of pictographs pecked on the face of existing rocks, usually in the immediate vicinity of tombs. They include delineations of human beings, camels, horses, cattle, stag, antelope, ibex and mountain sheep. Some of the game animals are now absent from the regions where the pictographs occur. The present-day Mongols have no knowledge of these cultures. As to the archæology of the present Mongol culture in the Gobi, Mr. Nelson says it is non-existent.

In China, the Expeditions' archæological work along the Yangtze River Gorges and in Yunnan yield nothing older than the Neolithic stage.

CONCLUSION

Ten years have elapsed since the Central Asiatic Expeditions started their explorations in China and Mongolia. The record of accomplishments is one in which the leader, Doctor Roy Chapman Andrews, and his associates may take pride. Thousands of miles of but slightly known desert territory have been traversed and made known to the world. Many specimens of the living faunas and floras and of rocks and fossils have been collected and sent to leading museums in various parts of the world. More than a thousand forms new to science, or but little known, have been described, and the end is not yet in sight. Scientists throughout the world have followed with interest the work of these Expeditions and wherever they have been asked to coöperate they have cheerfully responded. To those generous contributors who have aided financially or otherwise in furthering the work of the Expeditions Doctor Andrews has expressed a debt of gratitude.

In this connection it is interesting to note that the published record of the Expeditions to November 1, 1932, contains descriptions of 1759 species while 6988 species are mentioned in check lists. The new forms include 5 new families, 2 new subfamilies, 72 new genera, 3 new subgenera, 391 new species, 67 new subspecies, 19 new varieties and 2 new mutations. These numbers doubtless will be increased when other specimens in the collections shall have been studied and the descriptions published.

When Doctor Andrews made his first motor-car journey across Mongolia in 1919 he saw a vast country, but he could hardly have surmised the far-reaching scientific results of his forthcoming large scale explorations of 1921–1930. Various Russian explorers during the years 1870–1900 had made extensive journeys into central Asia, but the results of their endeavors were but little known to English-speaking people. American, German and English explorers between 1862 and 1910 had traversed the marginal countries of Asia, but Mongolia remained an unknown quantity. Previous explorers had reported the Gobi barren of fossils, but Andrews and his colleagues have discovered a long series of fossil-bearing basins representing hundreds of millions of years and containing a superb record of animal life. The geologists of the Expeditions have collected an equally full series of rocks and outlined the entire earth history of north central Asia. The archæologists of the Expeditions have found important evidences of prehistoric man, but much work still remains to be done. Some of the unsolved problems of central Asia, as they appear to members of the Expeditions' staff and their co-workers, are presented in the following Chapter, LII.

CHAPTER LII

UNSOLVED PROBLEMS IN CENTRAL ASIA

By Various Authors

INTRODUCTION

By Chester A. Reeds and Charles P. Berkey

The preceding chapters of this volume have been devoted to a narrative account of the explorations of the Central Asiatic Expeditions in Mongolia and China and a summary statement concerning the Expeditions' field work and publications. This chapter deals with the unsolved problems which have arisen in the course of ten years' exploration in central Asia.

Although extensive areas of the Gobi Desert region and problems connected with several branches of natural science, as exhibited there, have been covered in this volume and in the other publications of the Expeditions, it is fully appreciated that most of the studies have been made in reconnaissance form only, and that many of them are still uncompleted and many problems unsolved. Many questions raised in the course of these investigations have not been discussed in any form, in the hope that more work could be done. We know, of course, that some problems will have to be left unsolved to await the attention of others able to give more extended study to them. They are not likely to be touched for many years, but, sooner or later, they are sure to be studied if such lines of investigation in the future still claim the interest of scientific men.

It seems appropriate, therefore, in concluding this volume, which is written after several years of field work and accompanying laboratory study, to assemble a partial list of the problems that seem to be promising for further investigation. A few may yet be covered in a preliminary way by studies still in progress on the material and data collected by the Expeditions, but for the most part, those here presented are not adequately covered by available data and would require additional field work.

Some of the problems arising out of the work of the Expeditions are presented under the following titles:

1. UNSOLVED GEOLOGIC PROBLEMS

By C. P. Berkey, A. W. Grabau, F. K. Morris and L. E. Spock

The chief result to be expected from any field reconnaissance is the discovery of problems. It may serve the present purpose, therefore, without claiming to make a comprehensive survey, to indicate the nature and range of work still to be done by listing some of the typical unsolved problems.

For convenience, the suggestions now made are grouped under a few major heads, such as Locality Studies, Stratigraphic Succession and Age Relations, Deformation and Structure, Volcanism, Petrogenesis, Physiographic Problems, Glacial History and Climate, Prehistoric Archæology and Mineral Resources.

Some of these are presented in the form of questions, others simply as topics or subjects. A few are given brief introductory explanation.

Most of these problems have been touched in other published articles or reports and an occasional one will be given more extended explanation in later volumes of this series. Volume III now in preparation will carry contributions on several of the topics listed.

Locality studies

Only the major lines of geologic structure and only a bare outline of geologic history have been sketched by the work already done. Some thousands of miles of reconnaissance traverses have been run and descriptions based on such observations as could be made under conditions of comparatively rapid travel are now a part of the record. In addition to this, ten localities

were given more extended study. These are covered by six geologic locality maps already issued, and four ready for early publication.

Immense tracts of country, however, are still wholly untouched, and there must be many areas worthy of similar attention. Some of them doubtless promise as valuable scientific returns as any that have been reached by the Central Asiatic Expeditions. Localities known to offer exceptional advantages are noted in connection with certain of the problems listed under other heads.

Stratigraphic succession and age relations

The major objectives of the geologists of the Central Asiatic Expeditions have been to develop a series of geologic structure sections across the Gobi region, to help build a usable geologic column, and to outline the major elements of the geologic history as applied to this portion of central Asia.

Despite the reconnaissance character of much of the work, it is believed that the major structural features are correctly determined. Occasional local uncertainties do not greatly affect the larger general result, partly because of the fact that similar conditions are usually encountered at several places and consequently the uncertainties due to the obscurities of one locality are cleared up by the plainer evidence of other places. Nevertheless, there are gaps of major significance and these remain as appropriate problems for additional investigation. A longer and more detailed list could be made, but the following items serve to indicate the nature and range of this problem.

The greatest gap in the whole geologic column as thus far developed appears to be in the Palæozoic Era. Early Palæozoic strata may be represented but have not been identified. Two gaps come in the Mesozoic Era with similar uncertainty about the time covered, one at the beginning of the era and the other just preceding Cretaceous time. It is possible that localities may be found in which these portions of the column can be corrected and partially filled.

Subdivision of the pre-Cambrian.—The subdivision of the pre-Cambrian given by Willis and Blackwelder in their "Researches in China," has been accepted as applicable to the pre-Cambrian of Mongolia. The T'ai Shan complex, it is assumed, is separated from the Wu T'ai system and this in turn from the Nan K'ou system by some sort of unconformity. Somewhere in the Gobi region complete structural evidence of the separateness of these systems and the nature of their structural relation ought to be exhibited. At least one such locality was crossed by the traverses of the Expedition where conditions appeared to be favorable for the solution of this question. This locality is on the divide between the Tola River and the Ongin Gol in the vicinity of miles 870–880 covered in the traverse of 1922. (See volume II, page 117.) At this

place there is a distinct unconformity marked by a basal conglomerate occurring in the midst of extensive well-exposed metamorphic formations. Similar formations have been found at many other places, but at no place coming within direct observation of the geologists of the Expedition were so many critical features evident.

It is also a fair question whether Sinian rocks are really present in the Gobi region.

On the return journey from the Altai Mountains in 1922, a large area of greenstone was crossed between "Bilgoho Flats" and Jisu Honguer, the character and relation of which to other systems or formations could not be determined in the brief time available. The center of this area is at Camp Greenstone Gulch at mile 521, as located on the geologic sections of Volume II, page 179. It would probably be possible to determine with reasonable certainty the structural relations of this formation to others of the pre-Cambrian systems if this district were made the center of a locality study. These rocks represent a phase of the pre-Cambrian not elsewhere well exhibited, and a better understanding of their significance would add a chapter to the geologic history of the pre-Cambrian.

Age and correlation of the Khangai Graywacke Series.—The great series of graywackes and associated slates, extensively developed along the Tola River, were regarded as pre-Cambrian in age by the Third Asiatic Expedition. Strata similar in general appearance are found in many other localities and at an occasional place Palæozoic fossils are found. Permian shales and graywackes are found at Jisu Honguer. The most extensive graywacke tracts, however, are wholly non-fossiliferous and of very doubtful age. In general, these non-fossiliferous strata are more metamorphosed than the others. It is believed, therefore, that the Khangai graywacke series is much older and wholly different from the fossil-bearing strata of similar appearance, with which they may readily be confused.

Nevertheless, it still remains to prove the structural and stratigraphic relations of the various graywacke strata in Mongolia and explain the causes of confusion. At Jisu Honguer Palæozoic strata are infolded and downfaulted so as to bring two supposedly different graywacke formations together. It is surprisingly difficult to detect and trace these structures; but it is our belief that this question could be fully settled by further studies in the district between Jisu Honguer and Sair Usu in the so-called "choppy sea" district where both fossiliferous and non-fossiliferous strata are exposed. An essentially similar problem is presented by the fossiliferous Palæozoic limestones east of the Kalgan-Urga road.

Pre-Permian Stratigraphy.—Doctor Grabau, author of the volume on the Permian of Mongolia, has suggested the desirability of comparison of the

Lower Carboniferous Viséen and Tournaisian with the Kusnezk beds, and the Japanese beds; also a study of the relation between these and the Lower Permian. He raises question whether later Carboniferous beds are to be found between and the nature of the transition or hiatus; whether the Dinantian is complete or only partially developed; and whether the Upper Devonian is marine or continental.

In tracing the extent of the Upper Devonian seas, we meet with a problem that may well be solved by further studies in Mongolia and Siberia. Russian geologists have postulated a broad area of Upper Devonian sandstones and limestones in the Transbaikal—in the Gasimursk Mountains, and along the Shilka, Argun and upper Seya River basins. In eastern Siberia, thick beds of sandstones and shales, without fossils, have been assigned tentatively to the Devonian by some of the Russian geologists, while others would assign them to the Lower Carboniferous. Grabau considers that during Upper Devonian time, the Mongolian Geosyncline extended through this portion of Siberia to the Pacific. An orderlyfield-study of the entire region between the Minuzinsk basin, the Altai ranges and the Seya river is the only way to read the Devonian history of this region. So close a relation exists between the Asiatic and North American Devonian faunas, as to suggest a connecting passage. If any Lower Devonian beds exist they are probably continental according to Prof. Grabau's view.

Although Devonian rocks have been found in the Mongolian Geosyncline, the time when the sinking of the great trough first began is still unknown. If the geosyncline began to sink during Silurian time, the location of the old-land that supplied the sediments becomes a major problem in palæogeography; for to the north, the Irkutsk basin was depressed and receiving marine sediments. It seems almost impossible that the Irkutsk basin and the Mongolian Geosyncline were flooded at the same time. Almost all of the sandstones of the region are graywackes extremely rich in lithic grains. The abundance of undecomposed rock grains implies that the distance which the grains traveled from their rock source to their resting place was not great. It seems probable that the Khangai arch supplied sediments to the Irkutsk basin during Silurian time, and that the Mongolian Geosyncline came into existence only in Devonian time. The finding of pre-Devonian Palæozoic sediments in the Mongolian Geosyncline would seriously change our concept of the dynamic history of Asia.

No marine beds representing the Lower Dinantian or Tournaisian have been found east of the 90th meridian, except in Japan. In China the oldest Carboniferous beds are referable to the succeeding Viséen epoch.

The sea transgressed widely over the land during Viséen time. Fossils of this series have been recognized by Professor Grabau in the limestones collected near Sair Usu by the geologists of the Expeditions. Viséen beds are also known

in the Province of Echigo, Japan, and certain of the type fossils of the Mongolian Geosyncline have been found in the Baird shales of the Sierra Nevada in California. It is of great importance to trace the history of this broad marine overlap.

Overlying the Dinantian are Permian marine beds; but we have not yet found the two in contact. Future explorers should carefully seek the contact, to show whether there is a disconformity between the two or whether other Carboniferous strata intervene between them.

Post-Permian Stratigraphy.—Are there any Triassic strata in Mongolia? This period is virtually unrepresented in Siberia and in north China. Is an explanation to be found in this interior region?

Though it is possible that some of the sediments that the Expedition mapped as Jurassic are actually of Triassic age, we do not consider this to be probable. No Triassic beds have been recognized in northern China, and in the field we found no evidence suggesting that the Jurassic sediments included more than one series of inland basin-deposits. The so-called "Permo-Triassic" beds of China give no evidence of being a true transition series; the unfossiliferous upper beds of the series are merely the continental Permian. It seems very probable that during the Triassic period, central Asia had not yet assumed a basin-form, but was a moderately uplifted country. The test of this important question should be a sedulous search for Triassic continental sediments, which, if found, might yield a rich harvest of discovery to the palæontologist.

A large area, extending from the Shara Murun district eastward beyond the Kalgan-Urga telegraph line, constitutes a single major depositional basin, which was receiving sediments during later Cretaceous and Tertiary time. In certain places the succession of formations varies considerably within comparatively short distances. It may be safely assumed that the larger basin was modified by local downwarpings and uparchings, and in places by downfaulting, so that at times it was divided into separate smaller basins of more restricted extent and of no great stability. More detailed study of the stratigraphic successions ought to reveal the areal extent, if not the reason for the existence of these separate basins.

Although most of the sediments are rather fine-textured fluvial and lacustrine deposits, there are several comparatively thick members consisting of coarse conglomerate and cross-bedded sandstones. The source of this coarse material is still unknown, and a further study might reveal not only the areas from which it was derived, but also the circumstances which made possible the transportation of such heavy material.

At Iren Dabasu the sediments have been stripped off by erosion, so that the fossiliferous strata of Cretaceous age are revealed below the Eocene deposits, and the oldrock floor is exposed. There are other similar deflation

hollows exposing strata of apparently Cretaceous age, and in all of them the lithology is markedly different from that of the Tertiary strata which lie above them. Generally the Cretaceous strata are separated from the overlying beds by a pronounced unconformity, and in some places they are faulted and tilted. These Cretaceous strata are not only unlike the overlying Tertiary sediments but are also different from each other. Additional study of these deposits ought to clear up some of these matters. The problem involves questions of sedimentation, deformation and stratigraphic correlation.

The most widespread sedimentary formation is the Tung Gur, the youngest of the mapable units yet discovered in the basin. This formation covers a vast area to the east of the Kalgan-Urga trail and may well be continuous to the Dalai Nor region in the eastern part of the Gobi many miles beyond the reach of the Central Asiatic Expeditions. The formation is of importance because it is one of the few units which promises to connect with work done in other regions.

Deformation and structure

Students of earth-physics consider that the continents are rafts of comparatively light, granitic rock floating upon a heavier basalt layer. Some authorities believe that these continental rafts are rigid, and retain their shape while moving great distances across the face of the earth. Another school maintains that the continents are more or less plastic, and that the southward flowage of the Asiatic block has resulted in stretching the northern and in crowding the southern portions—leaving detached fault-blocks in the north to form the New Siberia Islands, while southward flowage wrinkled up the arc-shaped ranges of the Altai; Kwenlun, Himalaya and Malayan Mountains.

To this question there is a critical test in the study of central Asia. It is the continent most suspected of southward flowage, and of great southward overthrusts. So it is particularly important that the explorer should record the structural lineaments of the entire region; he should infer whether the arrangements of faults implies a stretching or a compression of the earth; he should determine the overturning of folds, and should seek evidence of Alpine overthrusts. These are interesting theories and speculations on which, as yet, we have no definite conclusions. But the surface is only scratched. The region remains one of the most promising for evidence bearing on possible continental shift and instability.

An additional problem of orogenic history is the relationship, if any exists, between the migration of geosynclines with folding and block-faulting, such as that of the Altais, immediately following. There is something here which seems closely analogous to the Appalachian-Triassic history in eastern America, and the Coast Range-Desert Basin history in the West.

A great change in deformational habit came over central Asia in mid-Mesozoic time. The most apparent structures are great fault-blocks, but there are gentle folds also, and there are virtually no undisturbed strata of that age. The whole problem of mid-Mesozoic history, especially its physical geography and deformation, deserves additional field investigation.

The older strata involved in the internal structure of the Altai Mountains are folded, but that deformation clearly belonged to an earlier period than the block-faulting, which accounts for their present relief. These major structures are clear, but there are curious secondary effects and accompaniments of late faulting which invite much more detailed investigation.

On the route westward from the central plains of Mongolia toward Sinkiang, there is a general increase in the abundance of lavas of Mesozoic and later age. Furthermore, the country is cut into tilted blocks and splinters by rather regular systems of faults, which may be part of the Altai tectonics. These displacements are of different ages, but the more conspicuous ones are post-Cretaceous. Since both the block-faulting and the evidences of volcanism increase in intensity westward, it is believed that there may well be some causal relation between the faulting and volcanism. This problem is not a new one. Considerable attention has been given to certain aspects of it by the Expeditions during the explorations of the earlier years, but it invites additional study.

Since the beginning of Tertiary time, the chief movements affecting the Gobi region are recorded in simple warpings, elevations, subsidences and block-faulting. The amplitudes of the differential movements range from simple displacements of a few inches to those which measure more than 10,000 feet. In some cases the same strata that cover the down-thrown block are found on the back slopes of the adjacent elevated one, and the evidence is plain that they were originally continuous. Exhibits of such deformation are developed on the finest and largest scale in the Altai region. Other places showing deformation on a smaller scale exhibit similar superficial conditions in that the sedimentary cover is still in evidence.

It is perfectly clear, therefore, that whatever has caused the deformation is not dependent on surface shift of load. This is a result, not a cause. The cause lies much deeper and must be connected with subterranean conditions, the nature of which it would be profitable to discover. It is the opinion of the geologists of the Expeditions that all of these deformations have been actuated by the same controlling forces or agents, that they are primarily volcanic in nature, and that they result in disturbance of isostatic balance because of local deep-seated changes in density, or changes in crustal thickness and continuity. But it is possible that geophysical observations could be made that would throw light on this question. Certain elements, usually confused with the problem, are clearly eliminated here. It seems, therefore, that it

might be possible to reduce the problem to simple enough terms so that more reliable conclusions than usual could be drawn from well-directed geophysical observations.

Volcanism

A great variety of igneous phenomena is exhibited in the Gobi region, and an occasional feature is well displayed. A few localities or special features deserve investigation.

In general it is known that lavas come from comparatively deep sources. Occasional smaller amounts may be derived from shallower depths. Not often is direct evidence found. However, a district was crossed at mile 565 between Mount Tuerin and Urga, in the traverses of 1922, which it is believed would repay more careful study in connection with this question. At this place is a group of conical hills of typical volcanic cone form, which, on brief inspection, proved not to be volcanic cones in the ordinary sense, but simple erosion forms instead. Evidence was gathered indicating that at the vent some of the shales were actually fused by the heat of the escaping gases. Only a brief reconnaissance was made, but enough was seen to warrant the belief that this area would repay detailed study of its volcanic phenomena.

The numerous large areas of granite in the Gobi region also offer exceptional opportunity for studies in magmatic history. Although there is great variety of composition and structural character and relation in the associated igneous bodies, we have regarded them all as originating from a single magmatic mass. Some of these igneous members show much greater capacity for penetration than others. It is believed that some of these units belong to stages of magmatic development preceding maximum igneous activity and invasion, and that the later ones are normal products of differentiation produced as the great mass cooled, while new outbreaks and products mark subsequent rejuvenations.

If this is a true picture, granites of very different age could come from the same batholithic source, for a single geologic period would not be long enough to cover the life history of such a mass.

We have been led to believe from field observation that the development of the Mongolian batholith was a very long and complicated affair, the time stretching over several geologic periods and the product exhibiting great petrographic range and variety in many separate field units. To what extent this interpretation can be proved has not been fully demonstrated, but we are inclined to believe that the granites and associated igneous rocks of the Gobi region present one of the best fields in the world for such a study.

There ought to be a batholithic cycle, but the life history of a magmatic mass of batholithic proportions has not yet been written. Here there are liter-

ally hundreds of miles of exposed rock and thousands of individual representatives of related products or effects in almost every conceivable form and relation. It would seem to be an ideal background for study of this problem.

Reconnaissance studies of these Expeditions have shown that granites cut the non-fossiliferous graywackes and also that deeply eroded exposures of granite are unconformably overlain by Mesozoic sandstones and conglomerates. On this evidence it was concluded that the batholithic invasion took place either in pre-Cambrian or in early Palæozoic time. Observations made in certain other districts much farther south at Chap Ser and elsewhere, indicate that Palæozoic strata are also cut by granite. This raises two questions: whether all these granites are essentially the same age and consequently of late Palæozoic or post-Palæozoic age, or whether there are granites of very different ages. These questions are not settled to entire satisfaction, and probably cannot be settled without a great deal more attention to such questions in widely extended field work.

At several different localities extremely complex and structurally confused masses of igneous rocks of general porphyritic habit are known. The first place where these were distinguished clearly was in the Tsetsenwang region, where they were found closely associated with the sandstones and conglomerates of assumed Jurassic age. It was thought that they cut these formations, and on this account they were first regarded as Jurassic porphyries. Nevertheless, the actual structural relations were obscure and left the question of age somewhat unsettled. Later this same type of formation was found at many other places, generally quite separated from Mesozoic strata of any kind. And in one locality it seems likely that the porphyries are of Late Palæozoic age. In the course of time, the conviction grew that these rocks ought to be older, probably Palæozoic. No locality has been found thus far where the true structural and age relations could be worked out, and it is still an unsettled point. In short, the age of the complex porphyries is undetermined. The question could probably be settled by giving more detailed study to two or three special areas.

Petrographic problems

Of the many problems involving petrogenesis, that of the graywackes seems to be the most promising. Even the question of age may have to be settled by petrographic means. It is not at all clear how such an immense accumulation of this type of material could be formed or where its sources were, but a major contribution to the geology of central Asia could be made by settling this graywacke problem.

A second major petrographic study, dealing with the chemical consanguinities of several series of igneous rocks, connected either by age or source

relationship, has been carried to completion and will be included in a forthcoming volume.

Physiographic problems

Depressions without outlet are common in the Gobi region. Some of these are in comparatively loose sediments capable of removal by wind and are confidently believed to be simple deflation hollows. At some of these places there is little evidence of the work of any other process, but at others it is evident that erosion and transportation by water are preliminary and contributory steps which appear to be necessary to begin the program of loosening and removal. This combination of processes would account for most of the hollows, perhaps for all of them excavated in the simple later sediments, but it will not account for others excavated in crystalline rock such as granite. The factors contributing to this result must be different, at least in relative importance. Weathering as a process must be an important step; but it is strikingly localized and the reason has not been discovered. Perhaps the processes involved are similar to those which under other circumstances develop pediments. The whole problem deserves a more extended study, and this northern Gobi country is a suitable place in which to make the investigation.

The two largest areas of drifting sands encountered by the Central Asiatic Expeditions are: one which extends roughly southeast from Iren Dabasu, and another north of the Ordos. Neither has been seen from all sides, nor even crossed. Since the Gobi, as known to the members of the Expedition, is normally a rock and gravel desert, the sand areas are exceptional and require an explanation from both the geologic and meteorologic aspects. This study would require a complete mapping of their boundaries and some knowledge of the progression of the sands.

The Gobi region is largely a region of plains, ancient and modern. It is easy to accept some of them as peneplanes, and so they were described in the preliminary notices. Nevertheless, it is clear that those of latest development are not to be connected with any single widely developed stream erosion system or general base level. There is a general tendency to planation, but there is no single continuous plane or uniformity of level or general control. They are essentially a series of local developments and the general effect is produced by association of independent units. Together, they form the so-called "Gobi erosion plane" of the later Expedition reports. There is no reasonable doubt of the essential facts, but the overlapping of processes, the relative contribution of wind and water, and the nature of the control, as well as the criteria by which such planation may be distinguished, ought to be studied in greater detail. Perhaps some of the so-called peneplanes of former times have had a similar origin.

At very many places individual masses of semi-mountainous character are surrounded by gently sloping surfaces above which rises the central elevated core. The origin of these forms is a problem of major difficulty in this as well as other regions. Probably nowhere else are they more common or more perfectly developed, or do they show greater variety. Most of the smooth bordering surfaces slope gently away from the mountainous core on all sides and are made up of alluvial deposits. Such forms are depositional in origin. Some, however, are clearly erosion effects developed on sediments, whereas others have been cut in crystalline rock instead of sediments. Evidently these forms cannot be interpreted in all cases in the same manner. Without doubt they would well repay additional special study in this region of fine display and variety.

One of the striking and unexpected features of the landscape is the dominance of stream erosion; well marked valleys, gulches, canyons, badland topography and stream terraces are common features. Nevertheless, deposition is also common and in places or at times is the more conspicuous. That this change is apparently of cyclic character raises many questions.

No one can have noted the striking evidences of alternations of erosion and deposition as exhibited in the Gobi region without pondering on the question of causes and controls. The most striking exhibits of these two different processes are to be found on the borders of the Altai Mountains. Great alluvial fans, reaching many miles out into the adjacent basins, accumulated and subsequently were nearly destroyed by erosion which trenched them and removed most of the material to more distant places. After this was done, it is evident that there was another epoch of accumulation and that a new set of fans, almost as extensive as the first, was developed, which in due time was also eroded in like manner. No less than three such great epochs of accumulation are prominently represented in the bordering remnants of overlapping alluvial forms on the flanks of Baga Bogdo, each separated by profound erosion almost to the total destruction of the preceding accumulations.

These reversals of processes deserve more extended study. They can be correlated, we believe, with epochs more clearly defined elsewhere as to age, such as the glacial and interglacial epochs. If properly worked out, these studies ought to contribute materially to criteria for determining age relations in the Pleistocene beyond the glacial borders of that time. The laws that govern the development of these forms and the actual conditions they represent should be formulated in more definite terms than has as yet been done. It is our belief that complete data for such a study can be secured in this region.

It is commonly assumed that similar reversals mark rejuvenations dependent on dynamic adjustments such as elevation or subsidence. Here it could probably be shown that a much more important factor is to be found in cyclic

change of climate and consequent change in volume and character of precipitation.

In the Gobi region there is a remarkable gradation in climatic conditions, and resultant geologic processes dependent on climate, from the relatively humid more elevated marginal borderlands to the comparatively arid and depressed central portions of the desert basins. Normal fluvial erosion processes prevail on the borderlands, checked and controlled by vegetation and relief. Desert conditions prevail in the central portion of the basins, and there erosion depends directly on wind and rain, checked little or not at all by vegetation. These climatic differences are recorded in erosion effects. In the intermediate ground all transitional stages may be found. At certain places one can find almost perfectly balanced conditions, where the advantages of one or the other factor are so delicately adjusted that the balance is often thrown from one side to the other in different seasons, or different years, or even in different formations or on differently exposed slopes.

At Baron Sog-in-Sumu, the balance is so perfect that some of the straight stretches of valley side are smooth and simple in form because they are well grassed and protected against destructive erosion, whereas the headlands or intertributary spurs, which are slightly more exposed to evaporation and loss of protecting vegetation, are eroded to badland form. The valley of Shara Murun and the edges of the adjacent uplands make a remarkable exhibit of this delicate climatic and dependent geologic balance. Probably few other regions offer such advantages for study of these intimate dependencies, and it is certain that much more detailed observations on these features would be rewarded.

In eastern Mongolia there are many lakes of varying sizes and in different stages of desiccation. Several of these were visited by the Expedition in 1928 but received only a cursory examination during a rapid reconnaissance. However, there are one or two good examples which present rather striking evidence of shrinkage which is interpreted as resulting from increasing aridity during Quaternary time. Furthermore, most of the lakes already seen are situated in lacustrine deposits of vast extent and late Tertiary age. Whether the region has been a lake district during the time under consideration is a question worthy of further investigation. The descending terrace levels around the larger lakes offer another angle of approach to the complicated problem of fluctuations of post-Tertiary climates.

Along the main caravan route that leads to Hami and Urumchi, the watercourses are more closely spaced and of greater magnitude than those encountered farther to the east. Also there is evidence that streams have been superimposed across resistant barriers which were exhumed during the removal of the later sediments. These features are conspicuous enough to suggest the

former existence of a well-integrated drainage system. Further and more detailed examination of the physiography of the area may yield information not only on climatic changes but on the Quaternary erosional history, which here appears to have followed a different course from that in eastern and central Mongolia.

Glacial history and climate

True glacial deposits are not extensively developed in Mongolia. There was no ice sheet, but there were numerous Alpine glaciers in the Altai Mountains and in the mountain ranges of the northern border. Deposits from these glaciers are interlocked with a succession of alluvial fans and these in turn with basin sediments, making a system that promises rich additional returns from detailed study. Correlation with European glacial epochs is a possibility.

Considerable evidence has been collected indicating cyclic changes of climate. Some of these, it is believed, can be traced back through the Pleistocene, and may correspond to the great cyclic fluctuations referred to elsewhere as Glacial and Interglacial epochs. In Mongolia there was insufficient precipitation to develop continental glaciation, but it is believed that the same climatic changes are marked by reversals of erosion and deposition. Minor changes of similar character are evident in the latest cycle, and are undoubtedly of special significance in connection with the development and prosperity of early man. It is possible that these climatic changes have been responsible primarily for some of his migrations.

This question has been touched by Huntington, Pumpelly, Davis and others. In the Gobi region there is a superior opportunity for further field investigation. For this purpose the borders of the Altai region, from the Gurbun Saikhan on the east to the mountains of the Kobdo region on the west, furnish the best localities.

Prehistoric archæology

In the Gobi region, the work of early man is represented by artifacts incorporated in the Shabarakh formation and related deposits. In the type locality at Shabarakh Usu, it is believed that these deposits bridge the time from the close of the Ice Age through the period of transition from glacial to desert climatic conditions of Recent time. For this occurrence the geologic evidence is reasonably well understood and correlated, but there are traces of much earlier man in Mongolia. Certain deposits, particularly those in the vicinity of Kholobolchi Nor, carry jasper fragments that appear to be crude artifacts. The same region records glacial occupation, with a succession of related deposits alternating with erosion intervals which suggest correlation with Glacial and Interglacial epochs as better understood and better repre-

sented in Europe and America. The field is very promising for additional investigation, both in unraveling the history of the Pleistocene and in tracing the advent and movement of early man in Mongolia.

It is possible, of course, that man may have lived before the Pleistocene. This region, because of the detail in which the geologic column and its horizons have been fixed by palæontologic finds, is particularly favorable for the precise dating of such material as may be found.

In several valleys traces of local irrigation works were noted, now fallen into disuse and almost obliterated by the changes of time. Occasional evidence of agricultural pursuit, such as a buhrstone for grinding grain, is found in the plain far beyond the borders of cultivation of the present day. At rare intervals one may see the ruins of an ancient wall marking a settlement where it must have been possible for men to dwell and find support. All of these are evidences of very different conditions in former time. There must have been a period of greater fertility of the soil and better support for a fixed population. It would be a matter of great human interest to acquire more information about these matters and match them with the other changes of this ever-changing region.

Dr. A. W. Grabau suggests: "Make determined search for Oligocene anthropoids. Recent developments in China lead one to urge a determined search for remains of '*Proanthropus*,' the most primitive human. He should be found in the Pliocene beds of Mongolia and Sinkiang. *Sinanthropus* or its very close relative should be found in the Pliocene of Sinkiang and Mongolia. Palæolithic man should be found in western and northern Siberia, that is, along the borders of the ice sheet north and west of the loess and desert country. Somewhere in that region should be the center of his development and radiation. Did he migrate to America from this region?"

Mineral resources

It would be a welcome contribution to discover important mineral resources in Mongolia and point out localities for possible exploitation. Thus far the Central Asiatic Expeditions have not discovered resources of apparent economic promise. There are enormous quantities of natural products of various kinds of too insignificant economic value to invite serious consideration. This is partly because of distance from market. Precious metals which might be exploited on a small scale, have not been discovered, but it is possible, of course, that some of these have been overlooked in the hurry of reconnaissance travel, and it is still more probable that other areas not reached at all by these Expeditions might furnish them. But the region so far examined is remarkably free from metallic mineralization. There is a little iron and a little copper but neither of any apparent promise. Despite the fact that there

are multitudes of veins, such as those at the east end of Artsa Bogdo, and extensive contact effects, the products are almost wholly non-metallic.

There are a few thin coal beds of very poor quality in the Mount Uskuk district. A few residuary lumps of asphaltic matter were found. There are occasional local salt-pans, but even these are not promising enough to deserve serious consideration for development. The natives gather a little salt for their own use, but there are no extensive deposits. Most of the coal probably would not burn, and there is no evidence whatever of important asphaltic or petroliferous content in any district visited. Nevertheless the search for mineral resources should not be wholly abandoned. There may be more promising ground not reached by the Expeditions, for it is well known that precious metals are found farther north and west beyond the reach of our own traverses.

2. UNSOLVED PROBLEMS IN VERTEBRATE PALÆONTOLOGY

By Henry Fairfield Osborn and Walter Granger

The Central Asiatic Expeditions have opened up in Mongolia a new world in vertebrate palæontology—probably the last to be discovered of the earth's great fossil fields. From a single fragment of the lower jaw of a titanothere known previous to the Expeditions' work in the Gobi, our knowledge has been extended to cover no less than sixteen fossiliferous horizons, four of which are Mesozoic and twelve Cenozoic. Some of these are represented only by small faunas, but many of them are known by large and adequate faunas. Many of the genera discovered, both reptilian and mammalian, show close affinities with North American forms; others are more distinctly European, while a few are exclusively Asiatic. The study of these faunas has an important bearing on the migration of Cretaceous and Tertiary quadrupeds and consequently upon former continental connections and separations.

There are still great unknown or unfossiliferous gaps to be filled in the prehistory of the ancient life of the Gobi Desert. Our explorations have as yet not revealed the closing periods of the Lower Cretaceous nor the closing period of the Upper Cretaceous in which large ceratopsians, like *Triceratops*, as well as large iguanodonts, like *Trachodon*, will doubtless be found. Nor have we discovered the fossil mammal fauna of Lower and Middle Eocene time corresponding to the Sparnacian, Ypresian, Lutetian and Bartonian of France, as well as to the Wasatch, Wind River and Lower Bridger of the Rocky Mountains.

For the Upper Eocene and Lower Oligocene there follows a period of extraordinarily rich fossiliferous horizons, extending through the Ligurian, Infra-Tongrian, Stampian and Aquitanian of France or the corresponding Uinta, early White River and John Day of the Rocky Mountains.

From mid-Oligocene to late Miocene time and again through Pliocene and early Pleistocene times, there are gaps in the sedimentary record of the Gobi—long periods of time either unrepresented or undiscovered or indicated only by very thin and almost barren strata. Interrupting this great gap we do have, as a late Miocene representative, the Tung Gur beds with their splendid fauna of proboscideans, ungulates and smaller forms.

One of the most remarkable features of the Cenozoic faunas of the Gobi, as exhibited by the extensive collections of the Expeditions, is the almost complete absence of the Equidæ. With the exception of two specimens of *Anchitherium* from the late Miocene Tung Gur beds, a single tooth of *Hipparion* from the Pliocene Hung Kureh, and a fragment of *Equus* jaw from a Pleistocene deposit, the horses are entirely unrepresented in our collections, and this fact presents an unsolved problem; especially so since *Hipparion* and *Equus* are found in great abundance throughout north China, and *Hipparion* has been found in abundance in Dr. J. G. Andersson's locality near the southern edge of the Mongolian plateau.

With the exception of the great breaks above mentioned, the prehistoric life of the Gobi constitutes a wonderful record of indigenous or autochthonous evolution of the mammals and reptiles as well as emigration to other continents and immigration from other continents. A hitherto great blank in the life history of the world has been filled, and central Asia is positively determined as bordering a northerly homeland of the greater number of the orders of mammals.

North of the 40th to 50th parallels of latitude, between which these discoveries by Andrews and Borissiak have been made, there lies a still undiscovered more northerly center of mammalian evolution which remains to be explored. We entirely agree with our distinguished colleague, William Diller Matthew, in his Memoir of 1915, "Climate and Evolution," that: "The principal lines of migration in later geological epochs have been radial from Holarctic centers of dispersal."

3. PROBLEMS IN MAMMALOGY

By Glover M. Allen

As a result of the intensive collecting carried on by the Asiatic Expeditions and other previous field workers, it may now be said that, in a general way, the mammals of Mongolia and China are fairly well known as to the species they represent, though much still remains to be worked out in the minor details of distribution and geographic variation, and especially in the study of their intimate habits and other related matters of biological interest. A summary account, with identification keys, such as is planned for the volume on mammals of this vast area, seems to be the next necessary step towards progress

in future work,—a knowledge of what has been accomplished and what still remains to be done.

The immense territory covered by this report offers a wide variety of biological conditions, covering as it does eastern Asia from about 20° north to 50° north, from the warmer latitudes just within the tropics to the north temperate zone with its short summers and cold winters, and from sea-level to the lofty snow peaks of the western highlands. It is clear from the work already done that this great area may be subdivided into smaller portions, each with characteristics of its own and inhabited by particular species or by representative races of such as are more widespread. The northern borders of Mongolia and parts of Chihli Province mark the southward limits of the evergreen forests that here encroach upon the Gobi Desert. This forest belt is a transcontinental zone with a certain sameness of fauna from east to west, thus carrying quite across Asia such species as the long-eared bat, badger, brown bear, stoat, common squirrel, beaver, red-backed mouse, roe, red deer and moose. Most of such species are represented at the extremes of their range by slightly modified subspecies, whose close relationship is in many cases demonstrable by the collections now available. Still other species, as the chipmunk or the common mole, do not extend across the entire distance, so that it becomes important to determine the present limits of their distribution, as throwing light on their past extension, and gradual shrinking away from former extreme points. This in turn should throw light on the causes for the extinction of species whose ranges, as shown by fossil remains, were once more extensive, while a comparison of such faunas with those now living will afford a basis for plotting the probable former limits of at least some of the types.

The intrusive eastern arm of the Gobi Desert apparently cut off to the southward a small area of this evergreen forest, so that, for example, red-backed mice occur in suitable sections of it in southern Shansi, yet the common squirrel does not seem to have accompanied them there. Why? The Gobi is tenanted by many peculiar types that have become closely adapted to a desert environment over a very long period. Many are leaping forms of several genera of jerboas and gerbils, others such as the mole-rats are burrowers; others, as the gazelles and wild ass, are capable of the swift and sustained running that is the price of life in open country. The connection of this intrusive element with the desert fauna of central Asia and its relationship to other desert faunas stretching almost continuously to northwestern Africa, merits further study. This is especially emphasized in the collections of the Asiatic Expeditions, for in many cases it is still impossible to say how different are the Gobi representatives of certain species from their relatives to the west. How different, for example, is the Persian gazelle from the supposedly different subspecies of the Gobi; are some of the species of gerbils described from the

latter area really but slightly different races of more western species, long known? The connecting links are still to be worked out as available specimens increase. In other cases, as with wild sheep and ibex, it seems likely that more races are given names than exist in reality, but it is still too early to be quite certain, on account of the few series that have been collected with anything like the thoroughness shown by those of the Asiatic Expeditions.

Southern China has many faunal elements quite distinctive of its warmer climate, and standing in strong contrast to the northern fauna, as, among others, various smaller insectivores of the genus *Crocidura*, although some are wider-ranging as well, the horseshoe bats, the red-bellied squirrels, the long-nosed squirrels of the genus *Dremomys*, muntjacs and water deer. The extreme south of China becomes subtropical and brings in the langurs, gibbons, fruit-bats, and many other warm-country species, some of which barely reach the edge of Chinese territory.

Finally, the great highland area of western China (Szechwan and Yunnan) seems to have been in part a refuge for many species no longer found elsewhere, some of them more primitive, annectent forms, especially in the case of the microtines; others are extraordinary types not known to have close relatives, such as the giant panda. In part, too, this high country shows decided affinity with the eastern Himalayas, possessing many genera in common, though these are represented in China apparently by more or less closely related races.

Through the work of the Asiatic Expeditions, an enormous amount of well-prepared material has been assembled from various strategic points, selected more or less so as to be representative of the chief faunal divisions of the great territory under consideration. This, in combination with previous collections, gives a fairly adequate picture of the mammalian fauna of Mongolia and China, while in many cases there are large enough series to show the range of individual variation and so indicate that many previously named species or races are not really entitled to recognition.

Intensive work may be said to have really begun with the labors of Père Armand David, the traveling French missionary-naturalist, who for several years in the late '60's and early '70's sent large collections to the Jardin des Plantes, Paris, where they were critically studied and published upon by Milne-Edwards, who later summarized these results in his splendid "Recherches." Much of this material seems to have been sent preserved in spirit and some was mounted and placed on exhibition, so that it becomes of great importance to have fresh and modern specimens available. David's first collections were made chiefly in north China, particularly in Chihli, and to a less extent on the borders of the Tsingling range. His most fruitful investigations, however, had to do with the fauna of the western Chinese highlands, where he secured for the first time so many of the species peculiar to that area,

including the giant panda, the pale race of takin, the curious snub-nosed monkey and a number of previously unknown types of insectivores, such as the short-tailed *Anourosorex*, the remarkable aquatic shrew *Nectogale* and the primitive mole-like *Uropsilus*, combining the characters of both shrews and moles. At about the same time Consul Swinhoe sent collections to London, chiefly from the coastal regions of Amoy and from Shantung. The later labors of Père Heude, notwithstanding his voluminous writings, have served rather to obscure than elucidate our knowledge of many of the larger mammals of China, since on account of his peculiar ideas of specific differences, he erected a large number of species on purely individual characters, with the result that of a vast number of names, it is hardly possible to disentangle the valid from the nominal. Happily the work of the Central Asiatic Expeditions, by assembling sufficient series from limited areas, has permitted the evaluation of many of these. Various brief expeditions into China during the last thirty years have brought much material to European museums, such as the journey of Prince Henri d'Orléans across Yunnan, the Filcher Expedition of 1903–1905, and the Weigold Expedition to Batang. Reports on the material thus secured have resulted in adding a certain number of new names, some of which, however, in the light of the specimens now available, seem ill-founded. By far the best collections of modernly prepared specimens made, up to the time of the Asiatic Expeditions, were those secured for the British Museum between 1907 and 1912 by the expeditions made possible through the patronage of the Duke of Bedford, the results of which are embodied in a number of short papers by Oldfield Thomas. Several Russian explorers have done good work in collecting mammals in parts of Mongolia and western China, especially Prjevalski, Kozloff, and Beresovski. The monographic account of the Prjevalski collections begun by Buechner was unfortunately never finished, and covers but a small part of the rodents. Other Europeans have from time to time made smaller collections of mammals, notably La Touche and Styan in southern China, Arthur de C. Sowerby and some of the Swedish travelers. Probably the British Museum has now the best representative collection of Chinese mammals, and the Museum of the Academy of Sciences at Leningrad the most extensive Mongolian and Siberian collections. Up to the time of the American Museum's first expedition, eastern Asiatic mammals were very poorly represented in American collections, that of the United States National Museum being almost the only one of any consequence. As a result, however, of Doctor Andrews' work, the Asiatic collections of the American Museum of Natural History are now in many respects unrivaled in North America, although those of the National Museum are also quite representative, and the Field Museum, through field work in recent years, has built up an excellent series.

While as a result of the field work now accomplished, a general view of

the Mongolian and Chinese mammal fauna is before us, it remains to fill in many details. Of first importance is the establishment of the affinities of many of the species with their representatives farther west, often longer known, and of which one or the other is to be considered often a local race. Thus the relationships of the Gobi gerbils and jerboas to those described from farther west are still to be worked out in certain cases. Again, most of the large game mammals are still inadequately represented, so that intergradation or its absence, though assumed, is in many cases yet to be proved, while even the limits of individual variation are frequently but imperfectly known. There is much yet to be found out in the details of distribution of those members of the Tibetan upland fauna that barely overlap the high steppes of western China. For example, the snow leopard, although its skin is often seen for sale in China, is not actually recorded as being found living within the Chinese borders, although it undoubtedly occurs in the high country of extreme western Szechwan. The large deer of western China are not at all well ascertained, while the validity of such races as *dejeani* of the Rusa, or of such species as *Cervus macneilli*, or of *C. wardi* based on antlers, is still to be made out. The number of species and recognizable races of bears is still a matter for study, but adequate material is not easily secured nor is there yet enough for determining many such questions. Most large species are represented in collections by far too few specimens to enable one to evaluate individual and geographic variation. Pocock's recent attempt to summarize our knowledge of Asiatic tigers and leopards brings out at once the inadequacy of the available material for study, notwithstanding the number of these animals killed by hunters or for trophies. Of smaller mammals, a more thorough knowledge of the distribution of certain species of rats and mice is important. Several native species so much resemble the European house rats and mice that they are not distinguished in the popular mind, but there is some evidence that in the larger towns it is the native varieties that act as parasites of man while the European species have become established to a much less extent than supposed. These considerations may become important in their bearing on the prevalence of certain diseases carried by these animals. Groups concerning which we are sadly in need of information are the Cetacea and the Pinnipedia; almost nothing is known of the species of seals occurring in Chinese waters and almost as little of its whales and porpoises. Of the cetaceans, the Pacific is the home of more species than are known from the Atlantic Ocean, so that the number at present known to occur must eventually be several times increased.

It is notable that in spite of the intensive collecting of the past few years, very few new genera or remarkable types were discovered. Nevertheless there are many species known from only one or two examples, for instance, Brelich's

monkey of Kweichow Province, the rock squirrel, *Rupestes*, of Yunnan, and the curious long-tailed cricetine, *Cansumys*, from Kansu. Further collecting in new intermediate localities will eventually go far toward filling in gaps in the known distribution of many species and their races. On the other hand, the very fact that so few specimens are known, is indicative of the greatly circumscribed area of their habitat. No doubt there are still to be found other such relicts of a former more widespread distribution, and these are most likely to occur in the south of China, as on isolated mountain ranges, with areas of forest still unspoiled. The parts of China whose mammalian fauna is still hardly known include the Provinces of Anhwei and Honan in the north (though probably these are similar in their species to the surrounding and better known areas) and especially the southern tier of Provinces, Kweichow, Hunan and Kiangsi. Of these areas almost nothing is recorded as to their mammalian life. Another important area is that lying along the entire southern frontier, where will undoubtedly be found a number of tropical or subtropical species whose northern range just overlaps southern China. The linking of this South-China fauna with that of Indo-China and Siam on the one hand and with that of Burma and India on the other must eventually give a far better understanding of the geographic relationships of the mammals of southeastern Asia.

Not least in point of interest will be the study of the relationship of the Chinese and Mongolian mammals to those of North America. The obvious similarity between the moose, wapiti, black bear, red fox, certain cats, rodents and insectivores on both sides of the North Pacific, offers much evidence as to the former closer connections of the two continents, while their dissimilarity may serve in part as a measure of the time during which they have been separated and climatic conditions have changed. A notable example is the jumping mouse, *Eozapus*, of Szechwan, which so closely resembles the American *Napæozapus;* while a remarkable contrast is offered by the American forest-living *Peromyscus* and its short-tailed burrowing representatives (*Cricetulus*) in eastern Asia.

It is believed that the work accomplished by the Asiatic Expeditions will go far toward establishing our knowledge of the species and relationships of the eastern Asiatic mammals upon a firm basis.

4. UNSOLVED PROBLEMS IN CHINESE ICHTHYOLOGY

By John T. Nichols

Introduction

The Central Asiatic Expeditions of the American Museum of Natural History have brought together general collections of fresh-water fishes from

representative localities in China. These make up what is probably the most nearly adequate representation of such fishes that has been assembled to date, and with its aid it is possible to obtain a fair idea of the fauna as a whole, which in the last analysis will probably be found to comprise some 500 forms. This supposes that even in the best known areas a few undescribed species still await discovery, and that close study of large series of specimens of various variable and difficult groups, from different parts of China, will lead to the recognition of a number of new forms well in excess of the number of such which will doubtless be found to be nearly nominal.

Our knowledge of the subject of Chinese ichthyology is by no means nearing completion, but at the present stage it will not be out of place to point out a few of its obvious desiderata as follows:

Unsolved problems in fresh-water fishes:

(1) Fauna of the Hsi-kiang (West River) valley.
(2) Definition or analysis of subdivisions of the Chinese faunal area.
(3) Correlation of ecological and faunal units with present and past physiography.
(4) The extent to which native fish-culture has affected the distribution and variation of certain species.

(1) The Hsi-kiang valley

The Yangtze Valley carries a rich, diversified and specialized unit fauna of fresh-water fishes. Recent collections from Fukien show that in this more broken country different species with a more restricted range are frequently to be met with. Considerable collections from Yunnan, which have for the most part gone to the British Museum, comprise many species closely related to one another, in this respect suggesting the extra-limital fauna of high Asia. It is probable that a rich fauna of fresh-water fishes is to be found in the Hsi-kiang Valley, from which no considerable collections have been obtained, due to the difficulty of the country. It is probable that these fishes will resemble those of the Yangtze but be slightly different, and that these with the fishes of Indo-China will show a gradual transition from the Indian to the Chinese fauna. Adequate collections, which will doubtless contain many undescribed forms, can alone settle this question.

(2) The Chinese faunal area

The fresh-water fishes of China form a rather well-marked unit fauna, which fades out along the edge of the desert to the north, and is quite unlike that of high Asia to the west. It probably blends off into the Indian fauna to the south and southwest, but considerable further collecting is requisite from

this direction. Manchuria appears to be a transition zone with a mixture of Chinese and Palæarctic species. Fishes with affinities to those of high Asia follow the uplands eastward into China, and field work in the western provinces carefully correlated with altitude and topography are requisite for delimiting the Chinese Faunal Area in that direction and to a better understanding of the two main faunas which come together there. It is clear that the Yangtze Valley forms an important subdivision of our area, but much ichthyological field work will have to be done before the physical boundaries of such can be placed with reasonable accuracy.

(3) Faunal units

Certain peculiar qualities, affinities and differences between the local faunas, or fresh-water fish associations of certain collecting stations, are very striking. They may in some cases be due to bygone chance, and unexplainable, but often seem well worth further investigation and study. For instance, why do certain genera show a notably greater variability in collections from Tsinan, Shantung, than from elsewhere? Why are certain species, generally of wide distribution, replaced by distinct representative forms at Hok'ou, Kiangsi? Or why are some forms, not of universal distribution, identical in the Yangtze and the Amur, in Fukien and in Formosa? In attempting to solve such problems one would need much more ecological and physiographic detail than is contained in the collector's notes, and as much physiographic history as is obtainable.

(4) Native fish-culture

Several fresh-water fishes are extensively cultivated by the Chinese. We may mention *Cyprinus carpio* (the carp), the genus *Hypophthalmichthys*, and *Labeo jordani*. This cultivation doubtless complicates the ranges of various species and sometimes causes confusion between artificial forms and natural races. A much more detailed knowledge of this fish-culture than is available would be advantageous.

5. ARCHÆOLOGICAL STUDIES AND PROBLEMS IN CENTRAL ASIA

By Nels C. Nelson

The archæological results obtained by the Central Asiatic Expeditions, joined with those published in recent years by Japanese, Swedish, French and Chinese investigators, have made it abundantly clear that greater China, in common with the rest of the Old World, witnessed a succession of prehistoric cultures, including both the Neolithic and Palæolithic stages. First and foremost, this means that, whereas a few years ago the reality of China's Stone Age was held in doubt, it is to-day a proved fact, and its great antiquity

is likewise thoroughly established. But while this positive accomplishment is noteworthy, it must at the same time be admitted that the evidence so far produced is widely scattered both geographically and chronologically, and that much remains to be done before the sporadic facts brought to light can be linked together into a connected story of development. It is with respect to this desideratum that the Central Asiatic Expeditions' Mongolia collections appear to be of special importance.

Sustained efforts on the part of Doctor Torii, Professor Hamada, and others have clarified the Neolithic and later stages in Korea and southern Manchuria. Dr. J. G. Andersson and his collaborators have made a good beginning on the same problem in Fengtien, in Honan and in Kansu, and their results have been supplemented by Doctor Barbour in Shansi, by Dr. Li Chi in Shensi and elsewhere, by Teilhard and Licent in northern Manchuria and eastern Mongolia and recently by Laukashkin in central Manchuria. Two additional but more superficial discoveries have been made also in southwest China: one by Mr. J. H. Edgar along the Yangtze River in Szechwan, and the other (ca. 1870) by Mr. J. Anderson near Bhamo in western Yunnan. All of these finds, together with minor more or less sourceless collections brought out from time to time by Dr. B. Laufer and others, have been indicative of Neolithic and later cultures.

In addition to the above mostly recent discoveries, Teilhard and Licent in 1923 brought to light definite evidence of a primitive Mousterian type of culture in the Pleistocene formations of the Ordos and adjacent districts. Finally, beginning in 1926 with the chance discovery by Swedish investigators of two human teeth in the Chou Kou Tien cave near Peking, this site, since 1928, under systematic excavation by Dr. Davidson Black and his Chinese co-workers, has yielded skeletal as well as cultural remains both older and more primitive than those of the Ordos.

There remains to add the contributions of the Central Asiatic Expeditions to these archæological investigations and to suggest their apparent significance. Reconnaissance work of more or less intensive character was carried out in three localities, viz., in both Inner and Outer Mongolia, along the Yangtze River in Hupeh and Szechwan and finally in central Yunnan. Yunnan was traversed from the Yuan Kiang (Red River) to the Yangtze in the longitude of Yunnanfu, and here were found faint surface traces of what cannot safely be regarded as anything but a Neolithic culture, that is, flaked and polished stone implements, usually associated with pottery. The Yangtze River was surveyed from the village of Kulowpei to a little above Wanhsien, and here also surface material of a late Neolithic character was obtained, not in caves but on the river bank and in the fields above. Only one stratified site of importance was discovered, immediately below the upper gorge, and this

was left practically untouched for future excavation. In Mongolia the Expeditions' work covered two seasons, and the numerous mostly surface sites from which collections were obtained range from longitude 101° to 114° plus, that is, from Orok Nor to the small-lake region north of Kalgan, in other words close to the Dalai Nor sites explored by Teilhard. These sites were almost uniformly rich in flaked and chipped stone artifacts, far less rich in ground stone, worked shell and potsherds, and, except for one or two eastern stations, devoid of bone objects.

These Mongolian collections, while mostly of surface origin and presumably incomplete inventories of the material cultures revealed, are nevertheless of more than ordinary importance when compared with the excavated results obtained by other explorers in the same general northern zone. The reason for this opinion is that the Gobi Desert and its borders were obviously in former times more habitable than they are at present, and the character of the archæological material suggests that the region was inhabited over a very long period, probably without marked interruptions. As the result partly of gradual desiccation, the local depositional processes have been largely replaced by those of wind erosion, in consequence of which the once stratified occurrences of archæological horizons have been destroyed and the industries of the later stages let down and mixed with those of earlier times. To separate this mixed material on purely typological considerations is of course a risky procedure, but it is not unwarranted. Besides, a comparison of the artifact inventories from the various sites gives ample grounds for at least a tentative chronological arrangement. Thus far only my own collections from the western two thirds of the area have been carefully studied, while those made by Alonzo Pond have been only superficially examined. Enough is known, however, to venture the opinion that the Mongolia collections supply some—perhaps all—of the links which are lacking to unite the sporadic Stone Age culture phases, brought to light in the general field from Chou Kou Tien, up to the Neolithic and later stages revealed by the Swedish and Japanese investigators. Specifically, this means that Mongolia furnishes indications of very ancient flakes resembling those of the Mousterian culture; it carries at least traces of the Upper Palæolithic, as suggested by the presence of the burin or engraving tool; it supplies an abundance of small implements suggestive of the Late Palæolithic, and it furnishes abundant evidence of a gradual transition from this Late Palæolithic to a fairly advanced stage of the Neolithic culture.

As to what remains to be done, suggestions are rather gratuitous at the present time. China, so far as I have observed, is a region of physiographic extremes: lowland areas in the northeast, more or less subject to floods and for the rest densely inhabited over a long period; wild mountainous areas in the southwest not so densely occupied and in part at least never, it would

seem, particularly suitable for primitive hunting folk. Wherever advantageous to-day, intensive agriculture has been in vogue for a long time and accordingly the prehistoric sites, if they have not been destroyed by natural forces, have been, in many cases at least, destroyed by man. This applies even to the cave débris removed by the farmers of the Yangtze Gorge region. Offhand, therefore, the most promising archæological fields in China would appear to be the deep loess deposits of the north, the foothill regions bordering the great flood plains of the major streams, and certain rockbound coastal areas, such as the Shantung peninsula and the Pacific shore from Hangchow Bay southward. Here at least shell heaps and caves are certain to occur, as indicated by Japanese discoveries in Manchuria, on the one hand, and by French discoveries in Tongkin on the other. Most promising of all, however, seems the region of the great Dzungarian gateway with its chain of lakes (Balkash, etc.) connecting Mongolia and Russian Turkestan. Through it, back and forth, must have passed an endless concentrated procession of migrating animals, making of it an ideal station for the primitive hunters. The Central Asiatic Expedition was well on its way to this imagined prehistoric paradise, and the archæologist's chief regret is that we failed to reach it.

6. PROBLEMS IN PALÆOBOTANY IN NORTHEASTERN ASIA

By Ralph W. Chaney

The modern forests of northeastern Asia have numerous elements in common with those of North America, and the origin of many of the trees of both continents in the same region during the past may be definitely predicated. It was, in fact, the migration of plants from a common center in the North which made possible the spread of dinosaurs and of mammals during the later chapters of geologic time. Like an army, animals may travel only when a food supply is available; the wide distribution of certain animals found in both hemispheres was made possible by an earlier advance of forest and grass over hills and plains out of the North. It is clear that the problems of animal migration are closely related to those of plants, and that the whole biota moved as a unit in response to the same changing conditions of climate and topography.

In contrast to the general uniformity of the forests of North America and northeastern Asia, there are certain species which characterize only limited areas in one or the other continent at the present time. The most striking American example is the redwood (*Sequoia*), and of the Asiatic trees, the ginkgo has the most restricted distribution. During the Tertiary, however, both of these trees are widely scattered over the northern hemisphere, as shown by the presence of fossil leaves, fruits and stems in the rocks of both continents. A collection recently made by Dr. T. D. A. Cockerell in southeastern Siberia

contains the foliage of both the ginkgo and the redwood, together with broad-leafed plants such as the maple and the birch which are still widely distributed. In many parts of western America, the fossil remains of ginkgo have been found in rocks of Middle Tertiary age. It is clear that during the past fifty million years living conditions have been altered over much of the northern hemisphere, and that certain sensitive trees such as the ginkgo and the redwood have been unable to maintain their Tertiary range down to the present.

Within the past few years, a considerable number of fossil records of the Tertiary forest have been found in northeastern Asia. In 1925, I collected material in Manchuria which adds in an important way to our knowledge of the former distribution of the redwood forest. Elsewhere in China and in Siberia, the remains of redwoods and associated trees are being discovered, and it is now possible to map much of the distribution of this redwood forest of the past. Within two years there have been collected on St. Lawrence Island, in the northern part of Bering Sea between Siberia and Alaska, fossils which indicate the former existence on this desolate arctic island of a redwood forest like that now living along the coast of California. The migration route of this forest can thus be traced across from Alaska to Siberia, but the evidence now at hand is not sufficient to indicate in which direction the redwood traveled, or whether it is a native of North America or a migrant from Asia.

A continued change in living conditions has been going on over the northern continents since the days when the redwood and the ginkgo were widespread forest trees. A trend from moist mild climate to cooler and dryer conditions is indicated by the change in fossil vegetation. Only recently have these later floras been found fossil in northeastern Asia, and it is noteworthy that they establish the same trend toward our present-day climates as is shown by the more abundant American fossil deposits. The gradual shifting of position of these forests due to climatic change, and the restriction or extinction of the more sensitive types such as the redwood and ginkgo, give definite evidence that in Asia as in North America living conditions are less favorable than they were in the past.

Due to the climatic barrier imposed by the Khingan range, rain-bearing winds do not reach the Mongolian plateau. As a result, this region is to-day without forests, a situation which appears to have characterized it far back into the past since fossil plants are rarely found in Mongolia. But to the east and south, living conditions have for ages been suited to forest growth; here the occurrence of plant fossils gives evidence regarding the nature and distribution of the forests of the past; through them the later chapters of the history of the earth may be read, and the relations to our own continent more fully understood.

7. PROBLEMS IN HERPETOLOGY

By Clifford H. Pope

Ever since and even before the appearance of Boettger's paper in 1888, many workers have studied the reptiles and amphibians of China casually, but the more serious publications of the last ten years have brought our knowledge of Chinese herpetology to a state comparable to that of any other large area of the earth's surface. This may lead one to conclude that little remains to be done, and such might be the case if China's fauna were not one of the richest and most interesting known. This extraordinary richness is due to several factors as follows:

1. The great area of China.
2. The extension of this area from the heart of the Palæarctic well into the Oriental realm, China being, in fact, the only area on the earth where these two realms come broadly in contact.
3. The extremely varied topographical features of China, including alluvial plains, elevated plateaus, high mountains, lakes, great rivers, innumerable mountain streams and an extensive coastline with outlying islands.
4. The varied climatic conditions ranging from the tropical forests of the south to the deserts of Mongolia and Turkestan.
5. An unusual geologic history that involved greater changes in some parts than in others but never a devastating glaciation.

These factors, taken en masse, bring to mind a multitude of problems, so few of which have received full attention that it is necessary to discuss them in groups.

The first and second, considered together, present a vast problem of zoögeography. Preliminary subdivision of China into regions and subregions has already been made by Mell, while Volume X of the present series will outline the distribution of every herpetological form, species by species. Such works are only foundations on which a complete structure may be erected, for I doubt if the full range of a single species in China can at present be worked out. In the field of zoögeography, then, accurate vertical as well as horizontal records of all forms should be made. This, of course, presupposes a knowledge of the various species and their known ranges, for it is useless to duplicate good records. As work progresses, new forms will be discovered and described in turn. The most promising parts of China for such studies are Kweichow, Yunnan and Szechwan. In these provinces, not only has relatively little work been done, but the varied topographical features, together with geographical position, have produced a fauna of unsurpassed richness. Nowhere else on earth are temperate and tropical faunas literally dovetailed into one

another by huge mountain ranges alternating with deep river valleys, all extending in a north-south direction. As the details of specific distribution are worked out, more exact limits of Palæarctic and Oriental realms as well as those of regions and subregions will become evident.

The third and fourth factors bring to mind numerous problems in ecology. The deserts, plains, plateaus, forests, rivers, streams, lakes, mountains and salt waters of China have their peculiar faunas, and all are worthy of special investigation. Ecological studies may be made by working out individual life histories or by collecting and correlating data bearing on special problems. A few habit studies have been made in eastern China, but no such work has ever been done in the west where the most local and interesting forms are found.

The recent awakening of interest in all branches of natural history among the Chinese themselves is a most encouraging sign and means that all work done on the faunas and floras of this immense country will have practical as well as theoretical value. This fact lends zest to the work.

8. A PROPOSED INTERNATIONAL INSTITUTION FOR ASIATIC RESEARCH

By Roy Chapman Andrews

During the progress of our work in Mongolia, I became increasingly impressed with the importance of scientific exploration in central Asia. A plan for a permanent research institution has gradually developed in my mind. Circumstances have forced me to abandon it, at least temporarily, but it is perhaps worth recording in the hope that it may be put into effect sometime in the future.

For convenience in this discussion, I shall designate as "Central Asia," Mongolia, southern Siberia, Chinese and Russian Turkestan and Tibet. There is no other region of the earth's surface, corresponding in size, which is scientifically so little known. Moreover, I believe that there is no other area which will yield such important results in almost every branch of natural science. Central Asia is the home of rapidly vanishing peoples and of ancient civilizations which have had a profound influence upon the history of the world. In it will be found the answers to important problems in anthropology, archæology, palæontology, geology, zoölogy, botany, geography, meteorology and other sciences. It is poorly mapped, its commercial resources are but little known, and in the realm of natural science we have had only a glimpse of its treasures. Because of its remoteness, its vast area, sparse population and its physical and climatic difficulties, its scientific exploration is by no means easy. Had this not been true, it would have been thoroughly explored long ago.

The scientific attack upon "Central Asia" should be undertaken systematically like the campaign of an army to insure the best results. The Central

Asiatic Expeditions were conducted in this way and were the outgrowth of my earlier zoölogical expeditions (see Chapter I, page 3). Thus the logical end of our work in Mongolia was a plan by which such investigations could become permanent and reach a much wider field. Briefly it is as follows:

What might be designated as an "International Institution for Asiatic Research" would be established with its executive center in New York and its field headquarters in Peking. As a beginning it would have an endowment of a million gold dollars which I had intended to raise personally. As the work progressed, this endowment could be expected to be materially enlarged, giving an ever increasing income for field research.

The scope of the Institution would be international. In addition to a President, Field Director and other necessary officers, it would have an Advisory Council, represented by distinguished specialists in various branches of science. This body would decide upon the general plan of research; project the work to be undertaken each year; the specialists who would be invited to participate, and the ultimate disposition of their collections. These would be deposited in various world institutions where they could be most advantageously studied and be accessible to the greatest number of workers in that particular field. In return for such collections, an amount to be decided upon by the Advisory Council would be expected to be contributed to the endowment of the "Asiatic Institution."

The Institution would not only finance each expedition but would arrange all details of governmental permits, transportation, servants, equipment, etc. When the particular scientists who had been invited to participate arrived at the point of departure, all preparations would have been completed. Without loss of time or energy they could go into the field and do their work.

These expeditions, necessarily requiring assistants of various kinds, would furnish an excellent training school for young scientists and explorers, who now find great difficulty in entering the field of scientific exploration.

Although the study of the collections would be undertaken at the institution where they were deposited, the scientific results would be published by the "Asiatic Institution" for world distribution.

The problems in natural sciences to be studied in "Central Asia" affect the educational and cultural life of the entire world; thus it is to be expected that the international aspect of the "Asiatic Institution" would insure the coöperation of the governments of the regions to be explored.

Peking offers by far the most practicable place for the field headquarters of such an Institution. It is at the gateway to Mongolia, and from China all the other regions of "Central Asia" can be reached with the least difficulty. As a first essential there must be the intelligent and active coöperation of the Chinese Government.

This brief exposition of the plan as I have conceived it must be understood to be an outline of the main features only. By careful study the details could be worked out on a practical basis and objections which leap to the mind could be overcome. I have discussed this proposed plan of organization with representatives of leading scientific institutions in various parts of the world, and without exception there has been enthusiastic agreement with its general principles. It is to be hoped that in the near future this plan, or something resembling it, may be put into effect. The cultural life of the world will be immeasurably richer when the treasure box of "Central Asia" has been unlocked.

FINAL GENERALIZATION OF RESULTS

Geology

1. For the first time it has been possible to give a fairly complete outline of the Mongolian geological column. It has been summarized in Figures 10, 11 and 12.
2. There are two great series of formations in Mongolia separated by a profound unconformity. The formations below the unconformity form a floor on which all of the later sediments rest.
3. The ancient floor beneath the basin sediments is enormously complex in structure. All the formations are folded and faulted and the later ones extensively metamorphosed. There are several unconformities, marking breaks in a history stretching from early pre-Cambrian beginnings to mid-Mesozoic time.
4. This complex ancient floor has been found to represent a portion of Mesozoic time, the latter third of Palæozoic time and three large sections of pre-Cambrian time.
5. An enormously extended granite bathylith, underlying all the region within the reach of these explorations, has been discovered and described.
6. The great break, or unconformity, between the simple later fossil-bearing sediments of the Gobi basins and the ancient rock floor is proven to be of pre-Cretaceous Age.
7. The youngest formation of the ancient floor on which this unconformity was developed is of mid-Mesozoic Age.
8. Interpretation of the strata indicates that this region of central Asia has been continuously a continental area since early Mesozoic time. The sediments deposited from mid-Mesozoic to the present are all of continental type, either fluvial, lacustrine or æolian.
9. On account of the basin-like character of the region and its simple sedimentation history, there is a succession of sediments belonging to Cretaceous and Tertiary ages.

10. Despite the basin character of the region and the continued deposition on the ancient floor from early Cretaceous time to the present, the sediments are almost everywhere thin, with many breaks or unrepresented intervals and many completely denuded areas. At no place has sedimentation been continuous. This is chiefly due to a remarkable series of warpings, and the shifting of centers of warping.
11. There have been several mountain-making periods, several erosion periods and several revivals of volcanism.
12. In Palæozoic and still more ancient time mountain folding was the dominant type of deformation.
13. The type of deformation changed in later time. In mid-Mesozoic time the block-faulting began to develop, and in later Mesozoic and Tertiary time block-faulting, accompanied by gentle warping, characterized the region.
14. The Altai ranges are great fault blocks, lifting complex folded formations to great height, but the mountains are not due to folding.
15. Deformation is probably continuing, for Pleistocene deposits are disturbed, and late planation surfaces are warped.
16. Despite the basin form of the region and the fine conditions for sedimentation, the major surface features are of erosional origin, including planation surfaces and erosion forms due to both water and wind.
17. There is no glacial history except small alpine glaciers in the highest mountains.
18. Evidence is conclusive that this region of central Mongolia has been arid and semi-arid in its climatic habit for many millions of years, but there have been cycles of greater and less aridity. This is indicated by systematic changes in the nature of deposits, changes in dominant processes, and in the surface forms produced.
19. Cycles of climatic change during Pleistocene and Recent time are indicated by special topographic features and superficial deposits.
20. The Gobi Desert is essentially a rock desert with a very thin veneer of shifting sand and much bare rock.
21. In Pleistocene time glacial epochs were represented in the Gobi region by a change to more humid climate, and interglacial epochs by return to desert conditions.
22. The close of the glacial period and the beginning of Recent time was marked by a change from comparatively humid climate to the modern desert climate.
23. The climate, however, even in Recent time, has not been uniform, and the curve of change has not been smooth. There have been

smaller changes within the longer cycles. Even within the last great arid cycle there have been epochs when the Gobi region was comparatively fruitful and could support a numerous population, separated by other epochs of more strictly desert habit and difficult conditions for animal life.

24. It is known now that man occupied the valleys of the Gobi region immediately after the close of the glacial period, and that his artifacts are buried in the natural sedimentary accumulations marking the return to desert climate.
25. The several different cultures of man noted in different places, which are undoubtedly of very different antiquity, probably correspond to recurrent favorable climatic conditions. In the intervening times conditions were too severe for these peoples to survive. Many reoccupations, therefore, are represented.
26. The region within the limits covered is not of great importance in mineral resources. —C. P. B.

Topography

A wholly new method of rapid mapping, adapted to a plains country where there are few natural landmarks, was developed by Major Roberts. By this method a continuous traverse of eight hundred and sixty-five miles was made from Kalgan northwestward through the heart of Mongolia. The elevations by which the topography was sketched were based on an instrumental vertical angle line. This was the first time that this method was used on the central Asian plateau. The work is recorded in a series of nineteen separate maps.

Secondary traverses were run by prismatic compass for many hundreds of miles and detail maps made of special areas. Altogether forty-four maps represent the Expeditions' contribution in this department.

The latitude and longitude positions of many key points in Mongolia were obtained, which, by checking and re-checking in different seasons, give accurate determinations and demonstrate many important errors in previously existing maps. —R. C. A.

Palæontology

In Vertebrate Palæontology one of the world's great fossil fields has been discovered and partially explored. Some fifteen distinct fossiliferous horizons have been determined. Of these, about two thirds are Cenozoic and one third Mesozoic, the range being from lowermost Cretaceous to Pleistocene.

In the earliest beds the presence of the great Sauropoda has been determined and unusually perfect skeletons of small predentate dinosaurs have

been obtained. Paper-shales of this same horizon have yielded a well preserved fish and invertebrate fauna. From the later Cretaceous beds there is a highly interesting fauna of trachodont and carnivorous dinosaurs and the now famous dinosaur eggs. The egg-laying dinosaur, *Protoceratops*, is known from perfect skeletons and from a remarkable series of skulls showing growth stages from newly hatched young to old adults. One of the most startling discoveries of the Expeditions was finding in the late Cretaceous *Protoceratops* beds several skulls and jaws of mammals representing four genera and six species of multituberculates and insectivores.

From the many Cenozoic faunas, a few of only the more interesting forms can be noted. The Paleocene beds have yielded a strange and interesting group of primitive mammals, mostly new to science but containing two forms closely related to American Paleocene mammals, which would indicate land connections during Early Tertiary time. Titanotheres, almost exclusively American before the Mongolian explorations, have been found in abundance and ranging in time from Upper Eocene to mid-Oligocene. These include the strange *Embolotherium*, the most distinctive and unusual fossil obtained from Mongolia. The archaic Amblypoda, formerly known from North America and Europe, are represented in the collections by many beautifully preserved skulls and jaws belonging to both the Coryphodont and Uintathere groups, and the order has now been extended up into the Middle Oligocene. The giant rhinocerid *Baluchitherium*, the largest of land mammals, has been found in abundance, and for the first time the skull and jaws are made known. One of the last discoveries to be made was that of the extraordinary shovel-tusked mastodon *Platybelodon*, found queerly enough almost simultaneously by other collectors in Russian Turkestan and in North America. Here again a wonderful series of skulls and jaws gives an age range from adults down to an actual fœtal young.

The study of these numerous reptilian and mammalian faunas will give much additional information as to the evolutionary processes which have taken place within the various groups represented and will also aid greatly in the general study of centers of origin and dispersal, migration routes and former intercontinental connections and separations.

As Professor Osborn has remarked, "these discoveries have established Mongolia as a treasure-house of the life-history of the Earth from the close of the Jurassic time onward to the close of the Pleistocene time, *revealing especially the hitherto unknown high continental life of Cretaceous and Tertiary times*. Consequently, the outstanding geologic discovery of the Expedition is, first, that Gobia since Jurassic time has been a central Asiatic continent extremely favorable to the evolution of reptiles, mammals, insects and plants hitherto known only along the Cretaceous shore-lines of Europe and the

Cretaceous sea-borders of the center of America; and, second, that this now terribly desert region, traversed by the gazelle and the wild ass, was certainly luxuriant with life throughout Cretaceous and Tertiary time, sparsely forested, with limited rain supply like the high-plateau regions of Africa to-day." The palæontological work of the Expeditions "revealed the high central Asiatic plateau as the home of most of the terrestrial dinosaurian reptiles of Upper Jurassic and of Cretaceous time. In brief, these discoveries establish Mongolia as a chief center of northern terrestrial life-history from the close of Jurassic time onwards to the very close of Pleistocene time." —W. G.

Archæology

The Gobi Desert and its borders were obviously in former times more habitable than they are at present, and the character of the archæological material suggests that the region was inhabited over a very long period, probably without marked interruptions. As the result partly of gradual desiccation, the local depositional processes have been largely replaced by those of wind erosion, in consequence of which the once stratified occurrences of archæological horizons have been destroyed and the industries of the later stages let down and mixed with those of earlier times. To separate this mixed material on purely typological considerations is of course a risky procedure, but it is not unwarranted. Besides, a comparison of the artifact inventories from the various sites gives ample grounds for at least a tentative chronological arrangement. Enough is known, however, to venture the opinion that the Mongolian collections supply some—perhaps all—of the links which are lacking to unite the sporadic Stone Age culture phases brought to light in the general field from Chou Kou Tien up to the Neolithic and later stages revealed by the Swedish and Japanese investigators. Specifically, this means that Mongolia furnishes indications of very ancient flakes resembling those of the Mousterian culture; it carries at least traces of the Upper Palæolithic, as suggested by the presence of the burin or engraving tool; it supplies an abundance of small implements suggestive of the Late Palæolithic and it furnishes abundant evidence of a gradual transition from this Late Palæolithic to a fairly advanced stage of the Neolithic culture. —N. C. N.

Zoölogy

The collections number approximately ten thousand mammals, eight thousand reptiles and amphibians and eight thousand fish from China and Mongolia. In addition to the description of many types new to science, the ranges and relationships of numerous species have been delineated and clarified. The collections have indicated the chief faunal divisions in China and Mongolia. For the first time, sufficient material from these regions has been

assembled to give a general view of the faunas and to make possible check-lists or handbooks of mammals, reptiles and amphibians and fish.

—R. C. A.

Botany and Palæobotany

About five hundred species comprise the botanical collections which give a comprehensive view of the flora of Mongolia south of the northern forests. Further studies of the distribution of the living plants will, it is hoped, throw light on the past climate.

A comparison between the climatic conditions of Mongolia and that portion of China lying immediately to the south during the Cretaceous and Tertiary periods brings out the fact that the relative difference in rainfall which now exists between these two areas has probably extended far back into geologic times. The northern provinces of China now have a rainfall of between 20 and 25 inches annually, which falls mostly during the summer in connection with the monsoon winds. These winds do not reach Mongolia because of the intervening Khingan Mountains and other ranges which run across northern China; the rainfall in Mongolia is only a few inches a year, and the trees are scattered or absent. On the basis of the fossil record, it may be suggested that these mountains were in existence through the Tertiary and back in the Cretaceous period, during which time a *Sequoia* forest whose moisture requirements were about 40 inches a year occupied their windward side; on the northern slopes, semi-arid and arid conditions not greatly unlike those of to-day appear to have existed, limiting the trees to conifers and poplars, and preventing the growth of any extensive forests.

The living trees of northern China and Japan are of special interest because of the similarity of the leaves of certain species to those of fossil species in the Tertiary of western North America. A species of hawthorn, *Cratægus pinnatifida*, has leaves which closely resemble those of the fossil *C. newberryi* of eastern Oregon, and there is no living American species which shows a like relationship. One of the common elms of northern China, *Ulmus parvifolia*, is much like a fossil elm from eastern Oregon which has no near relative, either living or fossil, in America.

Interestingly enough, the *Sequoia*, which is now limited to western North America, is found fossil in Manchuria. We therefore have the situation of certain kinds of trees which occur in North America as fossils but no longer live there, although they are present to-day in the forests of Asia; and there are others which, though now extinct, are shown by the fossil record to have lived in eastern Asia in the Tertiary, and which survive in the living forests of America.

Within the last two years, fossils which indicate the former existence of

a redwood forest like that now living in California, have been collected on St. Lawrence Island, in the northern part of the Bering Sea, between Siberia and Alaska. The migration route of this forest can thus be traced from America to Asia, but the evidence now at hand is not sufficient to indicate in which direction the redwood traveled. —R. W. C.

Photography

During the Expeditions' work, about fifty thousand feet of motion-picture film and many thousand still photographs were exposed. These record all aspects of the Expeditions' activities, as well as almost every phase of Mongolian life. Such a permanent record of a rapidly vanishing culture is of great value. —R. C. A.

The foregoing summary is a statement of only the most important general results of the Central Asiatic Expeditions up to the date of publication of this book. Study of the collections and data is continuing energetically and new facts are being elucidated almost every month. These will be made known in the succeeding volumes of this series.

PART IV

APPENDICES

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APPENDICES

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Leaird, Byron—Gatesville
Snell, Francis Arnold—1211 Esperson Building, Houston

VERMONT

†Barstow, Frederic D.—Chittenden
Davenport, Elizabeth B.—46 Western Avenue, Brattleboro

VERMONT (Cont'd)
Farr, Shirley—Brandon
Wilbur, James B.—Manchester

WASHINGTON
Fuller, Mrs. Eugene—1642 Federal Avenue, Seattle
Fuller, Richard Eugene—1642 Federal Avenue, Seattle
Trimble, William Pitt—Dexter Horton Building, Seattle

WEST VIRGINIA
Rumsey, W. E.—443 Park Street, Morgantown

WISCONSIN
†Clauder, Rudolph—119 West Water Street, Milwaukee
Logan Museum—Beloit College, Beloit
Vogel, Fred, Jr.—P. O. Box 883, Milwaukee

WYOMING
Stubbs, O. T.—Fox Park

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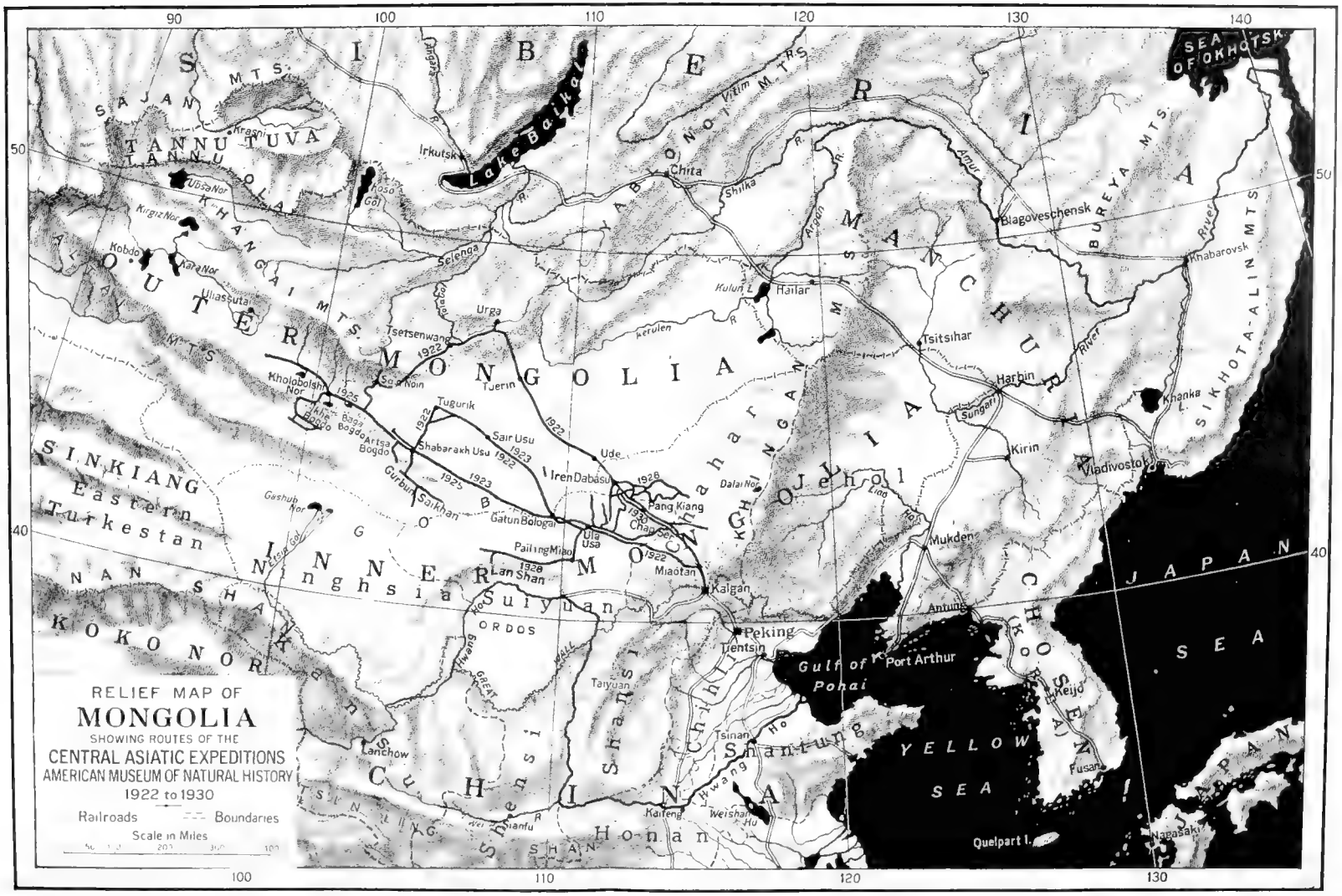
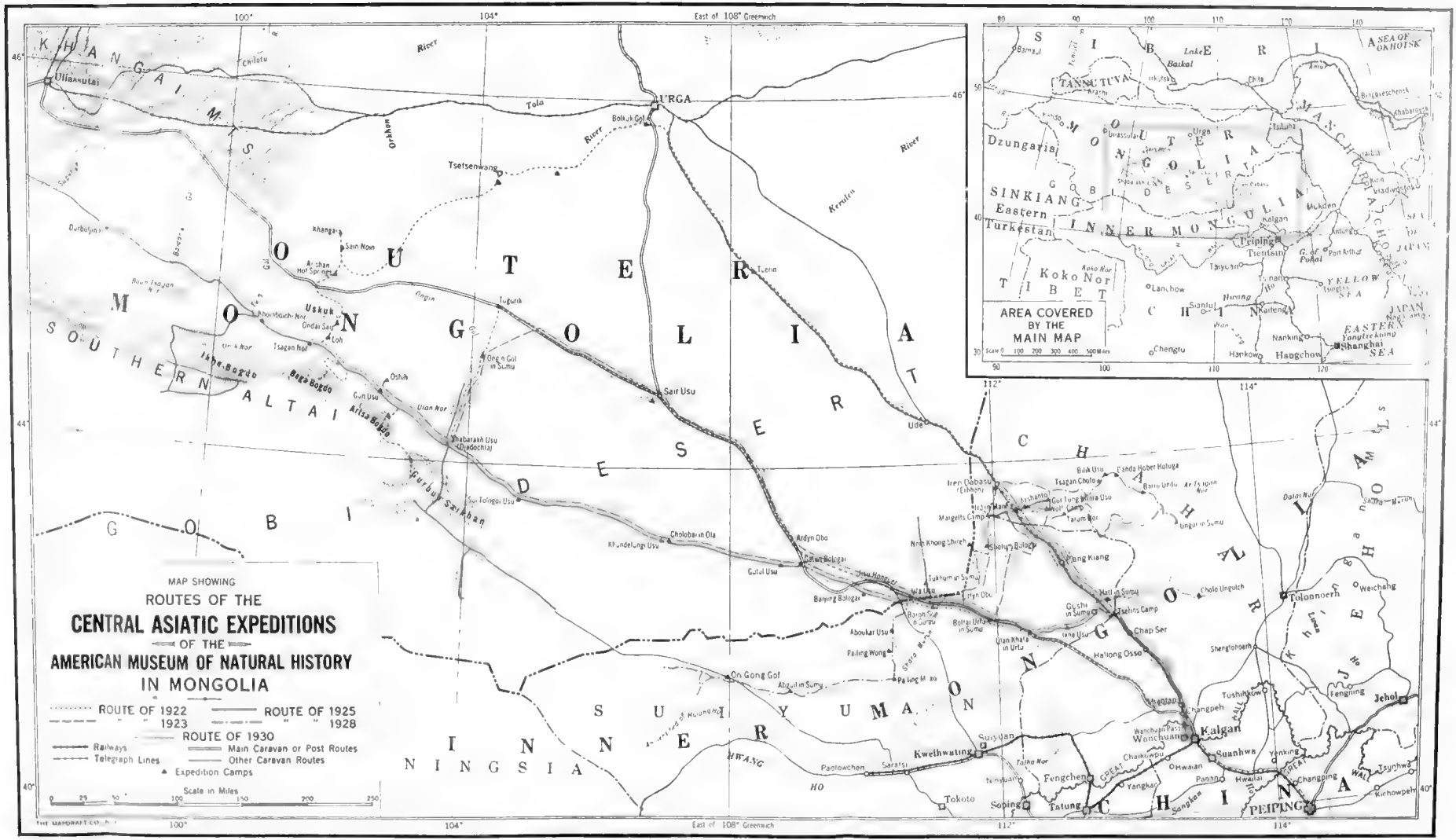
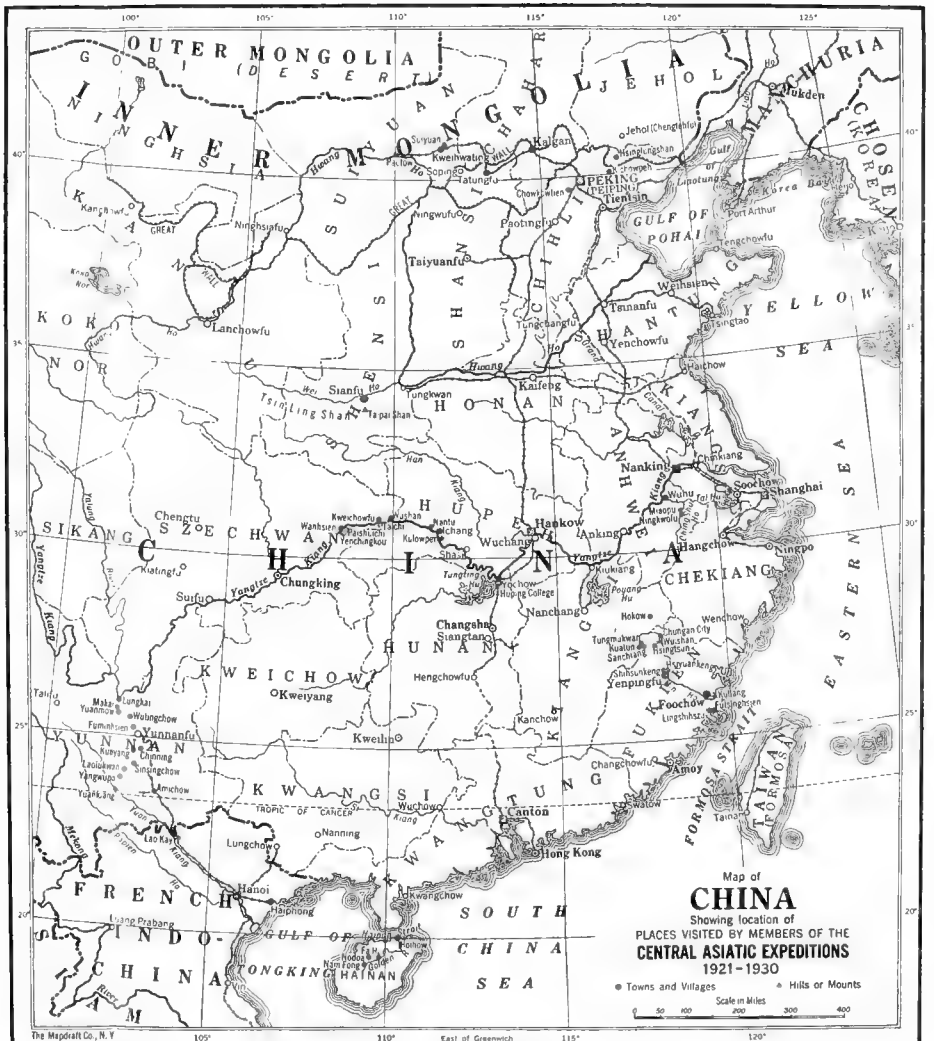
Place names are Mongolian unless otherwise designated.



Relief map of Mongolia showing routes, Central Asiatic Expeditions, 1922 - 1930.



Route map of the Central Asiatic Expeditions, 1922 - 1930.



Map of China showing in red location of places visited by members of the Central Asiatic Expeditions, 1921 - 1930.