Asiatic Expeditions of the American Museum of Natural History.

By Dr. HENRY FAIRFIELD OSBORN.

THE Third Asiatic Expedition was projected in the year 1920 as a sequel to American Museum explorations in Japan, Korea, China, and Mongolia, collectively known as the First and Second Asiatic Expeditions. The first and second expeditions were purely zoological in purpose; the third was planned to occupy the very much wider field of geology, palæontology, botany, zoology, and anthropology. The leader of these expeditions, Roy Chapman Andrews, crossed Mongolia during the season of 1919 and observed that the broad level stretches of the Gobi Desert, bordered with gentle terraces, lent themselves to exploration by automobile as well as by the older method of camel transportation, and he conceived the plan of a geological and palæontological expedition which should begin with widespread reconnaissance by light and heavy automobiles, while the large camel caravan could do the heavy transportation. A camel caravan travels two and a half miles an hour, fifteen miles a day; a well-equipped automobile train is capable of ten times this speed. This plan promised a double advantage over the work of previous explorers who had crossed the Gobi with only a camel transport, namely, Raphael Pumpelly (1864), Ferdinand von Richthofen (1877), and V. A. Obruchev (1894–96).

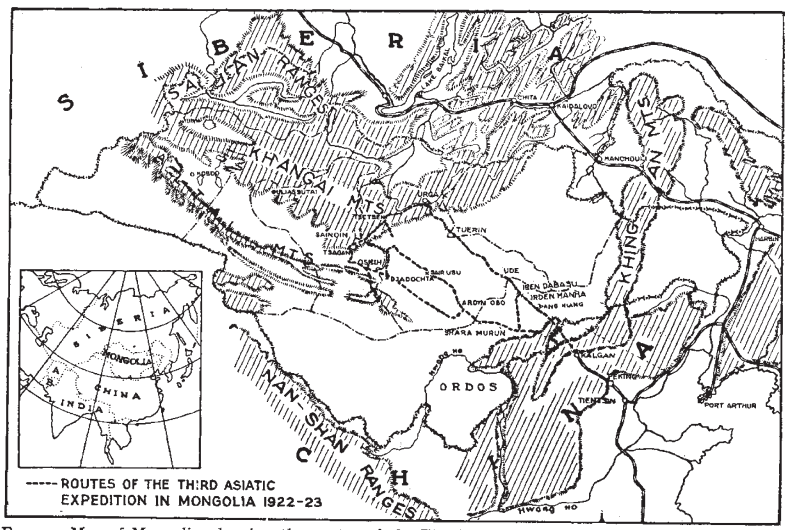

FIG. 1.—Map of Mongolia, showing the routes of the Third Asiatic Expedition. Mountainous areas are shaded with slanting lines, while the great basin of Mongolia is left white.

In the year 1920 Mr. Andrews submitted the plan to the president and trustees of the American Museum of Natural History, chiefly with the hope of putting to the test the theory advanced by the present writer in 1889 and 1890, that the high plateau region of central Asia would be found to be the chief homeland or centre of origin, evolution, and distribution of the great orders of mammals. With this main stated object and the discovery of the principal centre of human origin as the chief popular object, Mr. Andrews aroused widespread public interest and succeeded in financing the expedition for a five-year period, 1921–26. The first year, 1921, was devoted to organisation in China and Mongolia, to the assemblage of the scientific staff and the *matériel* of the expedition. The second year, 1922, was given to a three-thousand-mile reconnaissance in the Gobi Desert and, for a short time, in the Khangai Mountains north of the desert. The third year, 1923, was given to intensive exploration in five of the most promising fossil-bearing formations discovered in 1922.

The 1922 party left Kalgan, northern China, on April 20, according to programme, as follows: Roy Chapman Andrews, leader and zoologist; Walter Granger, chief palæontologist; Charles P. Berkey, chief geologist; Frederick K. Morris, assistant geologist and topographer; S. Bayard Colgate, motor expert in charge of three light and two heavy automobiles; J. B. Shackelford, photographer. A camel caravan train of seventy-five camels left two months earlier and joined the party in the centre of the Gobi Desert. The entire personnel included twenty-three men—six Americans, eight Chinese, nine Mongolians. By the perfect organisation and combination of the modern and more ancient methods of desert transport, the party made a three-thousand-mile reconnaissance in the five months' season of 1922, to the north, to the north-west, south, and south-east, practically skirting the entire desert of Gobi east of the Altai Mountains, but leaving certain regions east of the Urga trail still unexplored.

Both the mechanical and the scientific plans of the expedition involved many hazards, because automobiles had never previously been used in scientific exploration in Mongolia, and the accomplishment of the main scientific purpose of the expedition by discovery of the extinct fossil life of Mongolia and the remains of prehistoric man was at best extremely doubtful. In all the early explorations, and even in more recent geological work, no land fossils had ever been found, with the exception of a single fragmentary rhinoceros jaw with two teeth, which was brought back by Obruchev.

The palæontological and geological results of the first year's reconnaissance were not only encouraging but also very surprising—in fact, they far exceeded our fondest expectations. Only three days after starting, the first bones of Baluchitherium were discovered in the Houldjin gravels, where Obruchev had found the fragmentary rhinoceros jaw. A day later, April 24, the rich dinosaur deposits of Iren Dabasu, 260 miles north of Kalgan, were located. On April 27 were discovered the rich upper Eocene titanothere zone of Irdin Manha and the Irdin Manha formation, by far the most extensive fossiliferous upper Eocene deposit known. The party journeyed north and west, the geologists recording a complete cross-section of

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all the rock structures traversed and determining the geologic history of the region. The great bathylith of central Mongolia was determined by Berkey and Morris in the traverse extending northward from Kalgan and westward to the Altai Mountains. For this granitic mass, the dimensions of which seem to compare favourably with the greatest bathyliths thus far known in other parts of the world, the name "the Great Mongolian Bathylith" is proposed. Above the bathylith is found an unconformity, covering early Palæozoic time; then a second unconformity between Palæozoic and Mesozoic time; finally "the Great Unconformity" which marks the close of Jurassic time.

From Jurassic time on, Mongolia has been continuously a continental surface, on which a series of more or less extensive *epicontinental* deposits were laid down. These epicontinental deposits extended in time from the base of the Cretaceous to the Pleistocene. The old rock floor which the bathylith invades includes deposits which range from the ancient Archæan gneisses to late Proterozoic graywackes and limestones which may well correspond with the Nan-K'ou series of von Richthofen. The epicontinental deposits above the old rock floor appear to correspond with the "Gobi Series" of Obruchev.

The technical, geological, and palæontological work of the expedition, largely accomplished in 1922, and continued and verified in 1923, was to analyse the "Gobi Series" of Obruchev into its component formations, beginning in lower Cretaceous time and extending to the close of the Tertiary. In every instance the geologist and topographer, and the four palæontologists worked together, and the rapid succession of important discoveries demonstrated over and over again the value of hand-in-hand work of highly trained field geologists and highly trained field palæontologists. The training of Prof. Berkey in the very difficult pre-Palæozoic and Palæozoic geology of the eastern United States was no less valuable than the quarter century of field experience in the deserts of western United States on the part of Mr. Granger and his able fossil-hunting assistants, Messrs. Kaisen, Olsen, and Johnson.

In the case of each of the three Cretaceous zones, only a single guiding fossil was found in the first season, namely, the skull of the primitive horned dinosaur Protoceratops and the skeletons of the two primitive iguanodonts, Protiguanodon and Psittacosaurus. The discovery of each of these guiding fossils required the sharpest vision and the most prolonged field training.

FIG. 2.—Members of the 1923 party of the Third Asiatic Expedition in camp at Irdin Manha. Middle row, left to right: Walter Granger, Prof. Henry Fairfield Osborn, Leader Roy Chapman Andrews, Frederick K. Morris, Peter Kaisen; top row (Americans), left to right: C. Vance Johnson, Albert F. Johnson, J. McKenzie Young, George Olsen. Two of the young Chinese members—Buckshot (front row, third from right) and Liu (top row, extreme right)—are now at the American Museum being trained as expert preparators. (Photograph by Walter Granger.)

Work during the season of 1923 on the Protoceratops zone proved it to be one of the richest and most remarkable dinosaur deposits of the world. It yielded seven clusters of the now famous dinosaur eggs, four of which were found *in situ*, apparently as they had been deposited, seventy-one skulls and several skeletons of Protoceratops, the ancestor of the great horned dinosaurs of Montana, and three new carnivorous dinosaurs, Velociraptor, Oviraptor, and Saurornithoides. This zone promises the complete life of mid-Cretaceous time in this hitherto unknown continent.

Altogether, eleven chief life zones were discovered in the season of 1922, and a twelfth zone in the season of 1923. In descending order these are as follows:

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Pleistocene	OLAN and DISKE, containing *Elephas* and *Rhinocerus*, reported by J. G. Andersson.
Upper Pliocene	HUNG KUREH, 2000 feet, containing the stag *Cervus*, antelope *Hipparion*, camel, beaver, mastodon.
Miocene (?)	PANG KIANG, 500 feet, containing fragment of a rodent jaw, near *Ochotona*.
Lower Miocene	LOH, containing primitive mastodons related to those of the lower Miocene of France, and a rhinocerid.
Oligocene	HSANDA GOL, 3000 feet, containing the giant *Baluchitherium grangeri*, 19 genera of carnivora, rodentia, insectivora resembling those of France and the Rocky Mountains; also ancestral types of the cattle, deer, and pig family.
	HOULDJIN, containing *Baluchitherium*.
Lower Oligocene	ARDYN OBO, 500 feet, containing fauna similar to that of the Oligocene phosphorites beds of France—*Cadurcotherium*, *Schizotherium*, *Cynodictis*, *Eumeryz* (possible ancestor of the deer family).
Upper Eocene	SHARA MURUN, 300 feet, a mammal fauna resembling that of northern Wyoming and southern Dakota—*Protitanotherium* almost identical with species of northern Utah, long-limbed *Aceratherium*, and other mammals.
	IRDIN MANHA, 50 feet, vast flood plain rich in mammals closely resembling those of the upper Eocene of the Rocky Mountains, including carnivores, insectivores, numerous species of titanotheres, and great herds of a diminutive lophiodont. Here occurs the giant primitive carnivorous animal, *Andrewsarchos*, named after the leader of the expedition; also a new form of the dinocerata named *Eudinoceras*.
	ARSHANTO, at the base of the Irdin Manha, yielding numerous small lophiodonts.
Lower Eocene	GASHATO, 200 feet, apparently lower Eocene.
Upper Cretaceous	IREN DABASU, 150 feet, containing middle-sized *Iguanodon*, and the bird-mimicking dinosaurs.
	DJADOCHTA, 500 feet, life zone of *Protoceratops andrewsi*, a partly Æolian formation, 500 feet, containing rich primitive dinosaur fauna of *Protoceratops* and three types of small carnivorous dinosaurs; *Velociraptor*; *Oviraptor*, a small bird-like dinosaur found resting on top of a cluster of dinosaur eggs; and *Saurornithoides*. In this formation were found the seven clusters of eggs, comprising thirty-five well-preserved eggs altogether. In one cluster are seen what appear to be embryo skeletons, probably of *Protoceratops*. Thus all the growth stages in this primitive horned dinosaur, from the egg to the adult, constitute a series which gives us for the first time the ontogeny of a dinosaur.
Lower Cretaceous	ONDAI SAIR, 500 feet, containing *Protiguanodon mongoliense*, small leaf-eating dinosaur related to the *Hypsilophodon foxi* of the Wealden of England, also paper shales with insect fauna.
	OSHIH (Ashile), 1500 feet, containing small parrot-beaked iguanodont dinosaur known as *Psittacosaurus mongoliensis*, and the sauropod *Asiatosaurus* and theropod *Prodeinodon*.

In these *fifteen* formations, representing at least *twelve* new life zones, the main object of the Third Asiatic Expedition, namely, "to test the theory of the central Asian origin of the mammalian life of Europe and America," has been accomplished. According to Osborn's prediction of 1890, proof has been found of the existence in central Asia of all the great orders and of many families of mammals, excepting those orders which by common consent originated in South America, and the four orders which originated in Africa, namely, the proboscideans, the hyracoids, the sirenians, and the toothed whales, according to Osborn (1890) and the discoveries of Beadnell and C. W. Andrews (1893). Surpassing the verification of this prediction as to the mammals, the central Asian plateau proves also to have been the centre of evolution and adaptive radiation of the great division of land reptiles known as dinosauria. From this great home-country of land reptiles and of land mammals, from Jurassic time onward, races migrated westward to Europe and eastward to North America, and this affords the long-desired and complete explanation of the community of the fauna of the Rocky Mountain region and of western Europe, in both Mesozoic and Cænozoic time.

It is a very significant fact in the history of palæontology that the homeland of the mammals during the Age of Mammals, and of the reptiles during the Age of Reptiles, is the very last to be discovered. Beginning with the first palæontological work toward the close of the eighteenth century in Europe, continuing with the thorough exploration of Europe and southern Asia during the nineteenth century, and with the wonderful discoveries in reptilian and mammalian history in North America and South America from the middle of the nineteenth century onward, the homeland was still left untouched and unexplored. Discoveries in North America were so extensive and so revolutionary that many thought the homeland had been revealed in our great western fossil beds. Positive claims were advanced by Ameghino for Patagonia as the homeland of proboscidea and primates. As a result of these discoveries in the western hemisphere, it proves true that several families of mammals did originate in North America and several orders of mammals in South America, but the ancestral stock from which these orders radiated is to be traced to the high plateau region of Asia, where similar causes prevailed first, in the origin of the terrestrial dinosaurs; second, in the origin of the mammals; finally, we may predict, in the origin of primitive man. These climatic and physiographic causes are an elevated country of the savannah type, largely open, partly forested, in which there was throughout a severe competition and struggle for existence leading to highly varied adaptive radiation.

The season of 1923 differed from that of 1922 in the intensive exploration of five of the chief formations discovered, namely, Iren Dabasu, Irdin Manha, Shara Murun, Ardyn Obo, and Djadochta, yielding altogether a great collection of fossils in a remarkable state of preservation. These fossils were safely transported a thousand miles across the Gobi by camel caravan in charge of Mongol drivers, and through superior technical methods reached the American Museum without the least injury. They are now being worked out of the rock by a large force of men in the museum laboratories and are being described by Messrs. Osborn, Matthew, Granger, and Gregory in a series of preliminary papers in *American Museum Novitates* and in more popular form in *Natural History* and *Asia Magazine*. The perfect state of preservation of the

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fossil bones and eggs, especially those from the Protoceratops zone, is without precedent; it appears as if wind-driven sand suddenly overcame large numbers of these animals and buried the nests of dinosaur eggs. Several of the Protoceratops skeletons were found entire; others were partly scattered. The little animal known as *Oviraptor philoceratops* (a name signifying "the egg-seizer with a preference for ceratopsian egg diet") was found directly above one of the nests. This terrestrial dinosaur fauna is entirely new to science because it belongs to a period known hitherto only in scattered deposits of littoral formations.

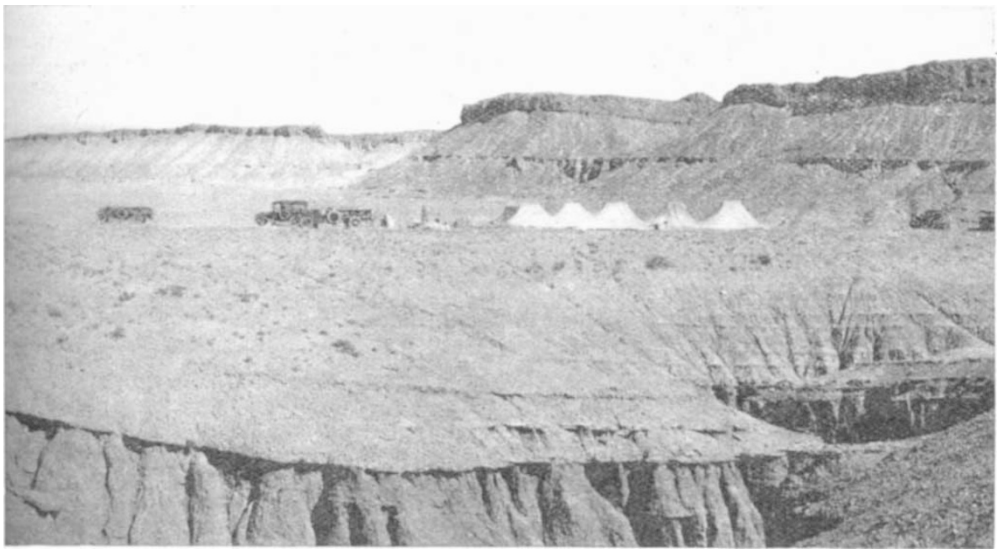

FIG. 3.—American Museum camp of the 1923 season on top of the lower Cretaceous formation Oshih (Ashile). Above is the Oshih plateau, which gives the region its name. Here were discovered the parrot-beaked iguanodont Psittacosaurus and the giant sauropod Asiatosaurus.

Interest in these discoveries, particularly in the dinosaur eggs, has been world-wide and makes evident a constantly increasing knowledge of palæontology and anthropology, which is a most hopeful sign for the future. Upwards of three thousand applications have been received for places on the expedition. The original plan of the Third Asiatic Expedition was to terminate in 1926 with excursions into unexplored portions of northern Tibet and perhaps of Chinese Turkestan, but the discoveries in Mongolia led to an important change of plan. Under the very active leadership of Mr. Andrews a new scientific and financial campaign, begun in November 1923, carried on in the chief cities of the United States, has resulted in a flow of contributions for the continuation of the expedition over a new five-year period beginning in 1924. The sum of 254,000 dollars has all been contributed, and subscriptions are coming from 235 individuals in twenty-five states. One of the leading automobile manufacturers of America has designed new cars, especially adapted for desert work.

The expedition will return to Mongolia with the original personnel, strengthened by a palæobotanist, Dr. Chaney, of the University of California, and an archæologist, Dr. Nelson, of the American Museum staff. The expedition throughout has enjoyed the hearty co-operation of the Geological Survey of China, which has contributed the services of one of its chief members, Dr. Amadeus Grabau, for the work in invertebrate palæontology and palæogeography. The expedition has been favoured by the friendly co-operation of the Mongol Government at Urga, and it is expected that this support will be continued. After seven months of campaign work in America, Mr. Andrews has returned to Peking and will outfit a caravan of two hundred camels to leave Kalgan in December so as to reach the future base of the expedition in western Mongolia in the month of May 1925. From this base, explorations will extend northward and south-westward, carrying the reconnaissance of 1922 into regions not previously explored. The upper Tertiary deposits will, in the meantime, be very carefully explored to test the new theory advanced by Osborn that we must look in the high plateau of Asia or of Europe for the Tertiary ancestors of man. The final publications of the Expedition will appear in a series of volumes entitled "Mongolia and China," of which volume i. will be the narrative of the expedition by Andrews. Volume ii., which will contain the observations and researches of Messrs. Berkey and Morris on the geology and topography, is now in preparation.

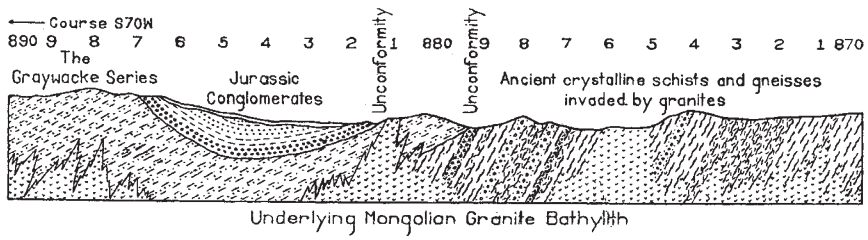

FIG. 4.—Diagrammatic cross-section of geologic relations at Tsetsenwan. This section lies about 200 miles wes of Urga, where erosion had exposed the granite bathylith and carried away most of its roof of graywack before the Jurassic sediments were laid down. A synclinal remnant of Jurassic conglomerate is preserved here, although several thousand feet of these strata are to be found only a few miles away.

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