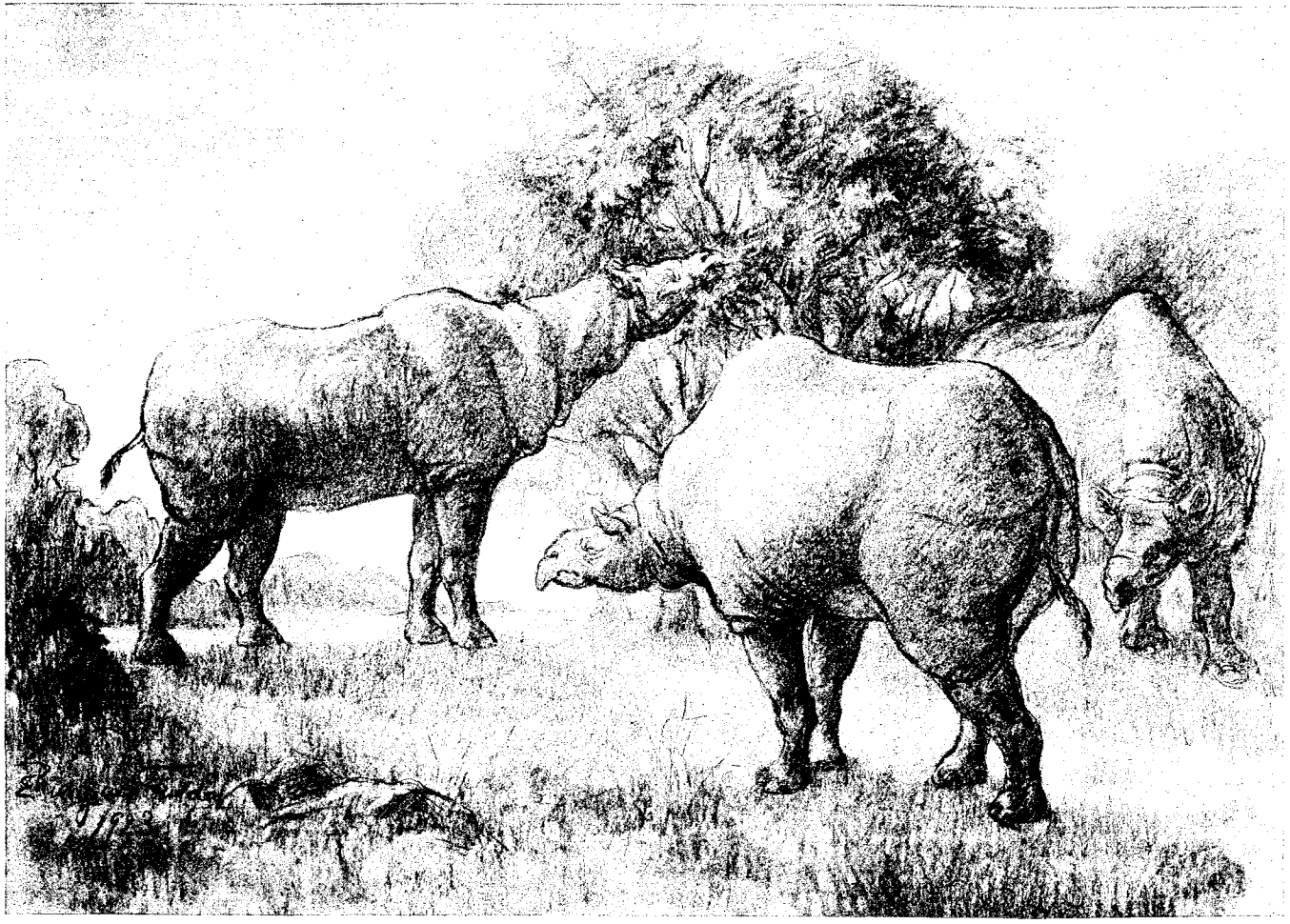

RESTORATION OF THE TREE-BROWSING BALUCHITHERES OF WESTERN AND CENTRAL ASIA
Drawn, under the direction of the writer, by E. Rungius Fulda, April, 1923

NATURAL HISTORY

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The Extinct Giant Rhinoceros Baluchitherium of Western and Central Asia

THE LARGEST RHINOCEROS OF ALL TIME—PROBABLY THE LARGEST OF TERRESTRIAL MAMMALS—COMPARED WITH OTHER RHINOCEROSES, LIVING AND EXTINCT

BY HENRY FAIRFIELD OSBORN

President of the American Museum of Natural History

This remarkable animal was first found near Chur-lando, Baluchistan, by the Cambridge University explorer and palæontologist, C. Forster Cooper, and described by him December, 1911; it was given the generic name *Baluchitherium*, to commemorate the region where it was discovered, and the specific name *osborni*, in honor of the writer of the present article. The second discovery was made near Turgai, a province of north Turkestan, by the Russian palæontologist, A. Borissiak, and named *Indricotherium asiaticum* in 1916. Neither discovery included the skull, although parts of the teeth were found, indicating an affinity to the rhinoceroses. The third discovery, revealing for the first time the creature's skull, was made in central Mongolia, by the Third Asiatic Expedition, which the American Museum is conducting in coöperation with the American Asiatic Society and with *Asia* and of which Mr. Roy Chapman Andrews is the leader. This find was named *Baluchitherium grangeri*, in honor of Walter Granger, the chief palæontologist of the expedition.

It is necessary to open this article with a brief outline of what we have previously known of the history of the horned and hornless rhinoceroses of the world, for without such an introduction we cannot give *Baluchitherium* its true setting among the great group of quadrupeds which originally derived its family name from the earliest rhinoceros known to the savants of western Europe, namely, the *Rhinoceros unicornis* of India.

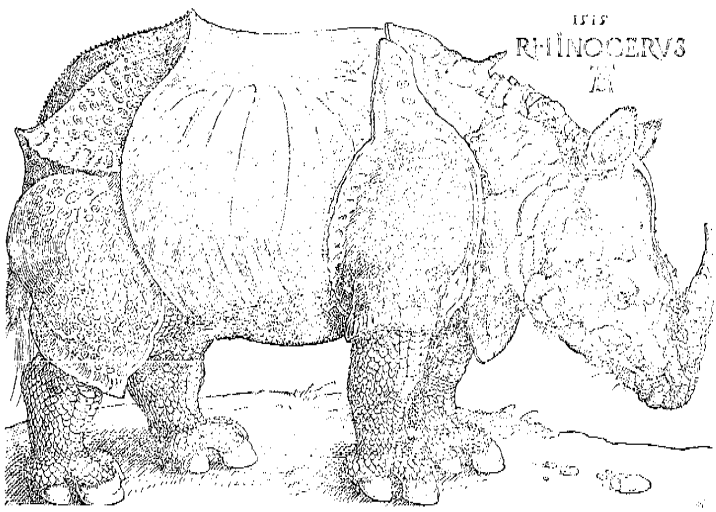
The Greek word rhinoceros is derived from *rhino* (ῥινό), nose, and *keras* (κέρας), horn, to which was added the Latin specific name *unicornis*, signifying jointly the animal which bears a single horn on the nasal region of the skull. This unicorn-rhinoceros—famous in the history of zoölogy, in animal mythology, where it appears as the unicorn, as well as in the history of medicine throughout the Middle Ages because the horn was supposed to have peculiar medicinal virtues[1]—was long believed to be the only rhinoceros in the world. But when Africa was opened up to explorers, the 'black' rhinoceros was discovered with its two horns, namely, a nasal and a median, and naturally was described in 1758 as *Rhinoceros bicornis*, signifying the two-horned rhinoceros. This discovery was followed in 1817 by the description of the giant 'white' rhinoceros of Africa, distinguished by its lighter grayish color from the black rhinoceros. To this 'gray-white' rhino the name *Rhinoceros simus* was given, the Latin-Greek specific name (Latin=*simus*, Greek=σιμός) signifying the flat-nosed or snub-nosed rhinoceros, in reference to the very broad snout adapted to grazing, quite different from the narrow and pointed snout of the black rhinoceros, which is adapted to browsing.

Long before this, however, fossil rhinoceroses began to be found. First came the discovery of the great *Rhinoceros antiquitatis*, so named by Blumenbach in 1799; this is the 'woolly' rhinoceros of the northern tundras of the

[1]See the article entitled "The Unicorn and His Horn," by Frederic A. Lucas, NATURAL HISTORY, Vol. XX, November-December, 1922, pp. 532-35.

Ice Age, a companion to the 'woolly' mammoth (*Elephas primigenius*), also named by Blumenbach. All of these living and fossil rhinoceroses, discovered in Asia, Africa, Siberia, and various parts of western Europe, were distinguished by the presence of either one or two horns, varying in proportions and culminating in the gigantic single-horned *Elasmotherium sibiricum* and the gray-white rhinoceros. Gray was the first (1867) to apply to the white rhinoceros the distinct generic name *Ceratotherium*.

Naturalists then began to be impressed with the differences in the cutting teeth of the rhinoceroses, which were composed not of *canine* tusks as in other quadrupeds, but of an enlarged pair of upper and lower incisor teeth,



After an etching of the "Rhinocerus" by Albrecht Dürer, dated 1515, presented to the American Museum by Dr. Bashford Dean. Comparing this remarkable etching with Philip Lutley Sclater's drawing of the *Rhinoceros unicornis* reproduced on page 219, we observe that Dürer has interpreted the dermal armature of the Indian rhinoceros in terms of the ornamented steel armor of the age of chivalry

in which the horn was borne not on the nasals but on the middle of the top of the skull.

Thus a great variety of generic names was successively applied, referring to horns of different kinds, as follows: *Dicerorhinus* Gloger (1841) and *Ceratorhinus* Gray (1867) to the primitive two-horned rhinoceros discovered in Sumatra; *Diceros* Gray (1821) to the two-horned black rhinoceros of Africa; and *Opsiceros* Gloger (1841) to both the African black rhinoceros (type) namely, the *second incisor* above and the *second incisor* below, corresponding with the tusks in the elephant family which are also second incisors above and below and not canines as would at first appear. Consequently naturalists began to distinguish the rhinoceroses by the presence or absence of their cutting teeth: for example, rhinoceroses without cutting teeth were all placed in the genus *Atelodus*, proposed by Pomel in 1853; the thick-jawed rhinoceros of Greece was named

Colodus, and the large-toothed rhinoceros of Archer, Florida, was named *Eusyodon* by Leidy.

All together between 1758, when Linnæus made the Indian rhinoceros the type of his genus *Rhinoceros*, and 1904, the year of the publication of Palmer's great *Index Generum Mammalium* (Index to the Genera of Mammals), not less than 42 generic names were proposed for the various kinds of rhinoceroses, many receiving several generic names which became synonyms of one another. Up to and including the years 1897 1905, when Trouessart's great *Catalogus Mammalium tam Viventium quam Fossilium* was written, upwards of 170 species of rhinoceroses, living and fossil, had been described.

HORNLESS RHINOCEROSES DISCOVERED, 1832–1911

Naturalists became so accustomed to the idea of one or two horns as a universal characteristic of the rhinoceros family, that in the year 1832 there came as a complete surprise the discovery of a skull near Eppelsheim in the vicinity of Darmstadt, Germany, of what was supposed to be a *hornless* rhinoceros. To this specimen the palæontologist Kaup gave the generic name of *Aceratherium*, signifying a rhinoceros without horns, the absence of horns being compensated for by a pair of strongly offensive upper and lower incisive tusks, to which the specific name *incisivum* refers; hence Kaup's animal was considered a hornless rhinoceros with incisive tusks. The writer's own observations, made during the year 1898 on this same specimen, are detailed below.

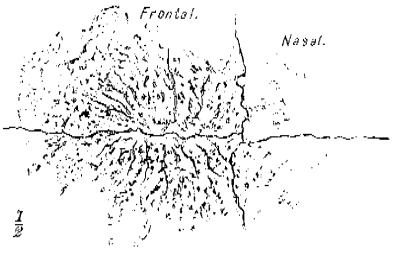
The timeliness of recalling Kaup's discovery at the present moment is that the great *Baluchitherium* also proves to be a hornless rhinoceros with very powerful incisive tusks, and at once the question arises as to its relationship to the *Aceratherium incisivum* of Kaup. In considering this question, we must first realize that *Baluchitherium grangeri* is of Oligocene or of Miocene age and is thus geologically more ancient than Kaup's *Aceratherium incisivum*, which is of Lower Pliocene age. Obviously *Baluchitherium* cannot be a descendant of *Aceratherium*, and with that possibility eliminated, another alternative suggests itself: whether it may not be a gigantic ancestor from which the Pliocene *Aceratherium* descended. We shall see that this conjecture must be answered with a decided negative, because *Baluchitherium* belongs to a distinct breed or line of hornless rhinoceroses, a line of evolution now made known for the first time by a series of discoveries beginning in 1911.

SEVEN DISTINCT LINES OF RHINOCEROSES, HORNED AND HORNLESS, RECOGNIZED BEFORE BALUCHITHERIUM WAS DISCOVERED

All the herbivorous quadrupeds tend to spread and migrate into different habitats and climates and into new feeding grounds of various kinds to which they become fitted through a principle of evolution which the writer has called *adaptive radiation*. The seven lines of rhinoceroses separated from each other at a very ancient period, and although externally similar in certain cases, they are really very far apart in their history and anatomy; even the two living African rhinoceroses probably separated from each other a million years ago. Thus the original genus *Rhinoceros* now includes numerous distinct branches of the great rhinoceros family.

During the years 1893–1905 the present writer was actively engaged in

the study of the living and extinct rhinoceroses of various parts of the world. At the time the multiplicity of 42 generic and upwards of 170 specific names was terrifying; it indicated an almost hopeless confusion in the minds of naturalists regarding the real relationships and affinities of these remarkable animals. There certainly could not be 42 different genera of rhinoceroses; the majority of these names must be synonyms. Nor was it likely that there could be 170 different species of rhinoceroses, highly varied as these animals were known to be in various stages of evolution. What key

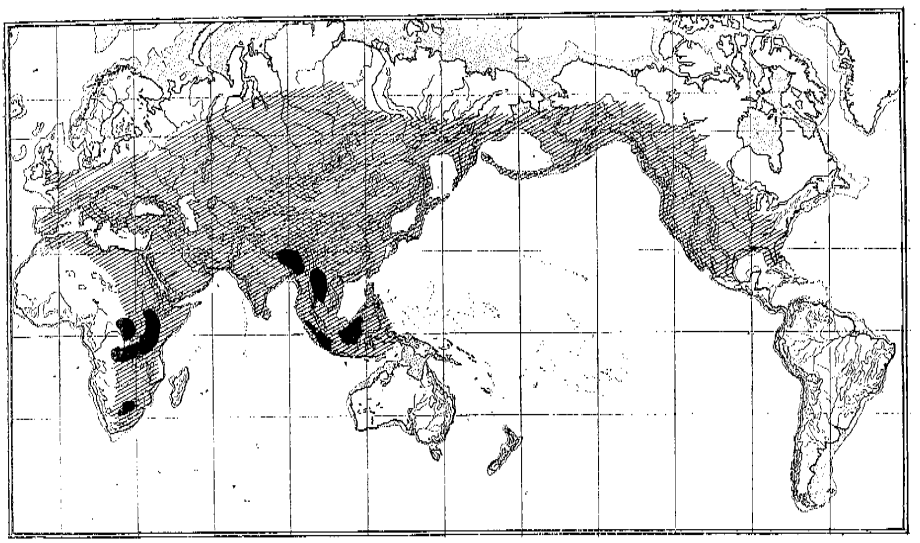


After the author's sketch of the horn rugosity at the union of the frontal and nasal bones of *Aceratherium incisivum*. Sketch made at Darmstadt Museum, August, 1900

could be found to this labyrinthine maze of names? The mode of search for such a key was indicated in the preface of the author's Memoir entitled *The Extinct Rhinoceroses*, published by the American Museum in 1898, namely, to arrive at a sound basis of classification for the anatomy and evolution of the rhinoceroses, derived from a comparison of their most primitive forms, according to the geologic period of their origin, and from a study of the characters in which various lines of rhinoceroses parallel or imitate each other, in contrast to those divergent characters in which they actually separate from each other in habits and habitat; thus laying the foundation of a true interpretation of their ancestral history.

In order to carry out this purpose, which the writer formulated during his study of the very primitive rhinoceroses of North America discovered in the course of the American Museum expeditions that were conducted between the years 1890–98, the writer made a journey during the summers of 1898 and 1900 through all the great natural history museums of Europe, London, Paris, Lyons, Munich, Darmstadt, Stuttgart, Augsburg, Vienna, St. Petersburg, and Moscow, where the principal types of fossil and living rhinoceroses described by the great palæontologists and zoölogists of Europe could be found, namely, the types of Blumenbach, of Cuvier, of Duvernoy, of Kaup, of Bronn, of Gaudry, and of other authors too numerous to mention.

In some instances these specimens were thickly covered with dust. In the ancient Museum of Darmstadt, for example, lay Kaup's classic type of *Aceratherium incisivum* on a shelf accumulating the dust of decades. The aged conservator was horror-stricken when a young American palæontologist appeared requesting the privilege of examining this venerable specimen more closely and only through a rather vigorous appeal to the distinguished geologist, Professor Richard Lepsius, did the writer succeed in having this ancient specimen brought out and placed on a table. By blowing upon it a few times and applying a duster the deposit of dust was removed, and, *presto*, the writer made a most interesting discovery which had completely escaped the learned eye of Professor Kaup in 1832, i.e., that this type skull bears indubitable proof of the presence



Rhinoceroses still survive only in the areas indicated in solid black on this map, namely, two species in Africa and three species in Asia. The oblique-line shading indicates the probable former range of these animals, including all the continents except Australia and South America. In North America the rhinoceros did not invade Mexico (in this respect the map is erroneous), but in Middle Miocene times it reached the eastern coast of Maryland, the Carolinas, and Florida

of a little horn right in the middle of its forehead, as shown in the accompanying sketch made by the writer before the eyes of the astonished curator, and that the name *Aceratherium*, or hornless, is therefore a misnomer. Thereupon, encouraged by this discovery, the dust was removed everywhere; rusty locks were opened; ancient trays filled with dust-covered specimens were taken down from the shelves. At times there were picturesque occurrences, for instance in the Imperial Museum of Moscow, where the head curator appeared in an ornate uniform to welcome the writer. As a rule, however, the work was hard and prosaic, requiring rapidly executed pencil sketches and volumes of notes, drawings, and memoranda; but the sequel was highly satisfactory. It was expressed in the writer's rhinoceros article entitled "Phylogeny of the Rhinoceroses of Europe," published as a *Bulletin* of the American Museum, December 11, 1900, in which the following conclusion was reached: that the true rhinoceroses of the Age of Mammals and of modern times belong in at least six great and distinct lines of descent and of evolution, which have been separated from each other since very early geologic times and from which lesser branches have been given off. The eight great lines now known are as follows:

I. Primitive hornless ACERATHERES of western Europe and North America, entirely hornless or with rudiments of horns on the forehead.

II. Primitive two-horned DICERATHERES, in which two little horns are placed side by side at the front of the nasals instead of tandemwise. These animals range from western Europe to North America.

III. Short-footed rhinoceroses, BRACHYPODINES, with a body shape like that of hippopotami, and a sharp, wedge-shaped horn at the very tip of the nasals. These migrated from western Europe to the southern United States.

IV. Tandem-horned rhinoceroses, CERATORHINES, chiefly of southern Asia and southern Europe, surviving in the Sumatran rhinoceros, now living in the forests of Sumatra; never finding their way to North America.

V. Typical rhinoceroses of India, RHINOCEROTINES, with a single anterior horn, *Rhinoceros indicus*, and its relative, *R. sondaicus*, and fossil ancestors.

VI. Rhinoceroses without cutting teeth, ATELODINES, of Africa, including the hook-lipped browsing *Diceros bicornis*, the broad-lipped grazing *Ceratotherium simum*, and fossil ancestors.

VII. ELASMOTHERES, or gigantic rhinoceroses of the tundras of northern Europe and Asia, with a single huge horn in the middle of the forehead.

VIII. BALUCHITHERES (Baluchitheriinæ), gigantic hornless rhinoceroses of the early Tertiary or Oligocene age of Asia, resembling the ACERATHERES but with stilted limbs attaining colossal height.

I. THE PRIMITIVE HORNLESS RHINOCEROSES, OR ACERATHERES

The Aceratheres are the simplest rhinoceroses known, appearing early in the Age of Mammals. They are found in southern Europe, southern Asia, and in our own western states, Colorado and South Dakota. At first they were no larger than tapirs, with perfectly smooth skull top devoid of a rudiment or sign of a horn either on the nasal or the frontal bones—thus typical Aceratheres. Undoubtedly the true Eocene ancestors of these animals still await discovery; we may come across them in Asia. Although there are animals very close to the ancestral rhinoceros stage among the varieties of the quadruped known as *Hyrachyus*, found near Fort Bridger in southwestern Wyoming, we are inclined to believe that North America was not the homeland of the rhinoceroses.

The first animal of this kind found in our western states was brought to Dr. Joseph Leidy of Philadelphia, the founder of mammalian palæontology in America; he recognized at once its general resemblance to the *Aceratherium* of Kaup (1832) and described it as *Aceratherium occidentale*, or the Acerathere of the West. Quite recently there were found in Colorado the fossil remains of a little herd of Aceratheres characterized by even more primitive structure and known as *Trigonias* from an upper jaw that had been described by Lucas in 1900. The name had been given because of the presence of triangular cutting teeth at each angle of the jaw, for these little animals possessed small upper canine tusks or eyeteeth, also third upper incisors, as well as second upper incisors, which were beginning to be enlarged to press against the tusklike lower incisor teeth. Another distinction of these animals was the possession of four digits on the front foot, unlike the living rhinoceros, which has only three, hence their specific name *tetradactylum*, signifying four-toed.

These Aceratheres were not only very numerous but very hardy, well protected from their enemies and vigorous. In Lower Oligocene times they ranged widely over the whole Northern Hemisphere, both in North America and Eurasia, including India. They branched out into several varieties of descendants, which culminated in Europe in the *Aceratherium incisivum* of the Lower Pliocene of Germany. In North America they survived into Middle Pliocene times, being represented by the *Aphelops megalodus*, the hornless and big-toothed Acerathere of western Colorado described by Cope in 1873, and also by the very long-limbed *Aphelops malacorhinus* of Cope, the hornless, soft-nosed Acerathere, and finally by the long-footed one, discovered by Leidy

in Florida and described in 1890 under the specific name *longipes*.

These Miocene and Lower Pliocene Aceratheres were almost as large as the existing Indian rhinoceroses. As a rule they were everywhere distinguished by very powerful lower incisor tusks, splendid fighting weapons; also by long limbs whereby they were able to run swiftly and thus escape their enemies; the snout was either absolutely smooth or, yielding to the rhinocerotine tendency, had nasal horn rudiments. Yet the forehead or median horn rudiment, as observed in the *Aceratherium incisivum* of Kaup, is also present in some of the American Aceratheres.

Typical Diceratheres of South Dakota, named *Diceratherium tridactylum*. The animals were drawn from a perfect skeleton discovered in 1892 and now in the American Museum. At this stage of evolution the horn rudiments were extremely slight; they appeared as paired rugosities on the nasal bones, and are observed only in old male specimens. These rugose areas are somewhat like the corresponding area shown in the sketch on page 212. Hence this animal was first regarded as an Aceratherе by Osborn, but later proved to be an ancestor of the true pair-horned Diceratheres

II. THE PAIR-HORNED RHINOCEROSES, OR DICERATHERES, OF EUROPE AND OF WESTERN NORTH AMERICA

The Diceratheres, like the Aceratheres, are very primitive and ancient, namely, of the Oligocene of France and of South Dakota. They closely resemble the Aceratheres in their long limbs, their relatively slender bodies, well raised off the ground, and their strongly offensive and defensive lower incisor tusks; they are of the size of tapirs and capable of rapid motion. They appear to differ, however, from the outset in two important characters: they have only three digits on the fore foot instead of the four found in the true Aceratheres; but still more important and characteristic is the position of the horns, which appear side by side on the top of the nasals instead of in the tandem arrangement peculiar to all other horned rhinoceroses.

The Diceratheres, therefore, are readily remembered as the pair-horned rhinoceroses. They too are great travelers, being very abundant in central France and in the Rocky Mountain region of South Dakota; from the latter locality superb specimens were described by Osborn in 1893 under the specific name *tridactylum* in contradistinction to *tetradactylum*. These

animals were found by the American Museum expedition in beds of Upper Oligocene age, and the paired horns were so rudimentary that it was not at first recognized that they were true Diceratheres, directly ancestral to the species *Diceratherium annectens*, i.e., the annectent Dicerathere, which had been described by Marsh from the John Day valley of Oregon in 1873, or to *Diceratherium armatum*, the well-armed Dicerathere, so named by Marsh in 1875, from the same region of Oregon. Professor Marsh was thus the first to set apart the pair-horned Diceratheres from all other rhinoceroses. The French palæontologists, Aymard, Filhol, and Duvernoy, hesitated to separate these pair-horned rhinoceroses, which they found very abundant in Upper Oligocene strata in France and in Germany, although Duvernoy named one of his specimens *Rhinoceros pleuroceros*, signifying that the horns were borne side by side. These animals do not appear to have been quite so vigorous or successful in their migrations and combats as the Aceratheres, although they are traced into the Lower Miocene near Orléans, namely, the *sables de l'Orléanais* of central France; and are perhaps even present in Baluchistan, where they are reported from beds in the Bugti Hills although this discovery awaits confirmation.

So far as we know, the Diceratheres died out in Lower Miocene times, whereas the Aceratheres persisted into Middle Pliocene times both in America and Eurasia.

III. THE SHORT-FOOTED RHINOCEROSES, BRACHYPODINES

In wide contrast to the cursorial and swift-traveling Aceratheres and Diceratheres, there appeared in Lower Miocene times in France, contemporary with one species of the Diceratheres, in the same river deposit now known as the *sables de l'Orléanais*, an animal first described by the French palæontologist Nouel as *Rhinoceros aurelianensis*, the rhinoceros of Orléans. This medium-sized rhino is the earliest known progenitor of one of the most extraordinary groups of rhinoceroses the world has known; extraordinary because, despite their excessively short limbs and feet to which the name *brachypodine* refers, and their low heavy bodies, probably adapted like that of the hippo to living along river borders, water courses, and in swampy lowlands, they traveled over the entire Northern Hemisphere in great herds, absolutely protected against their enemies by a very sharp pair of lower cutting tusks, which resemble those of the Aceratheres and of the Diceratheres, as well as by a very sharp, narrow, wedge-shaped horn placed on the very tip of the nasal bone. With this double protection and probably a very thick skin, they defied the Carnivora.

We find them in southern France in great numbers, in the quarries of the Island of Samos of the eastern Mediterranean, in the quarries of Maragha, Persia, in the Siwalik floodplain deposits of India, in the East Indies, and in Japan,—always migrating eastward. Finally they enter northern Asia, cross the Asiatic-American land bridge, reach North America, and, in Lower Pleistocene times, they not only spread over our western states as far south as Kansas, but penetrate even to Florida! Finally a great herd of these animals was discovered in 1883 in a quarry near Long Island, Phillips County, Kansas, by the veteran collector Charles Sternberg. This

wonderful quarry yielded rich collections to the University of Kansas, to the Museum of Comparative Zoölogy in Cambridge, to the United States National Museum, and to the American Museum.

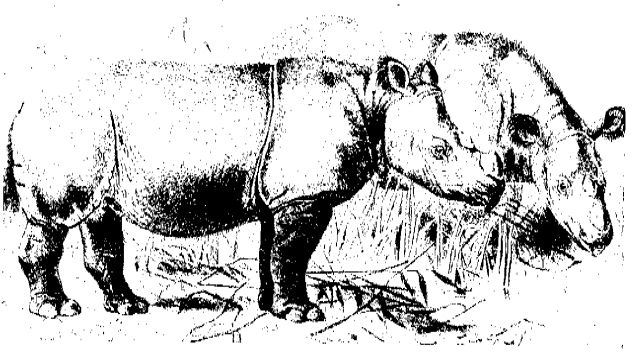
These animals, as first discovered in the Upper Miocene of France, received the specific name of *brachypus*, signifying the short-footed rhinoceroses: as found in the Lower Pliocene of Germany, they were given the specific name of *goldfussi*, after one of the German palæontologists. Later the American palæontologist Hatcher applied to them the generic name *Teleoceras*, signifying the end horn rhinoceros. From the collection, already referred to, that was obtained at Long Island, Kansas, Osborn in 1898 described *Teleoceras* as a broad-headed, extremely short-limbed rhinoceros, partly aquatic in its habits, with a very large brain and no diploë or spongy lining to the skull. The limbs were far shorter than those of any living type of rhinoceros. In the females the nasals bore a very small horn; in the males, especially as found in the Lower Pliocene of the Republican River, Nebraska, the nasals became greatly thickened at the extremities into a vertically compressed plate which bore a tall, thin, wedge-shaped horn. The body proportions were 10 feet in length, with a height at the withers of only a little over 4 feet, and with a girth of the abdomen at the ribs of 9 feet 2 inches. It was on the mounted skeleton from this same Long Island quarry that Charles R. Knight in 1898 based the beautiful restoration of *Teleoceras* that he drew under the direction of the writer, as shown in the accompanying illustration.

The short-footed or brachypodine rhinoceros, known as *Teleoceras fossiger*, as it appeared in Lower Pliocene times in the locality now known as Long Island, Kansas. After a painting by Charles R. Knight, made in 1898 under the direction of the author. This animal was almost certainly aquatic in its habits, and in a revised restoration it will be shown without the skin folds. It will then have more of the smooth, rounded appearance of the hippopotamus

IV. THE TANDEM-HORNED RHINOCEROSES, CERATORHINES, NOW SURVIVING IN SUMATRA, EASTERN BENGAL AND ASSAM

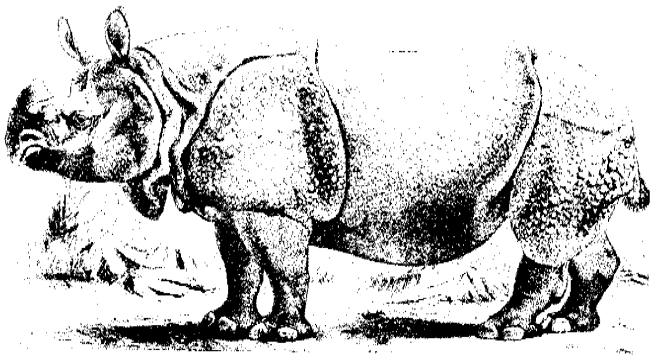
Unlike the tandem-horned rhinoceroses of Africa, which have no cutting teeth, these animals retain small cutting incisor tusks, supplemented by a pair of relatively small but very effective horns.

In a little fossil-bearing hill near Sansan (Gers), France, Lartet in 1848 discovered the diminutive animal which he called the rhinoceros of Sansan, the *Rhinoceros sansaniensis* of his "Notice sur la Colline de Sansan." Shortly afterwards, in the neighboring and somewhat more recent deposit of Simorre, he found the related rhinoceros of Simorre, i.e., *Rhinoceros simorrensis*, a diminutive tandem-horned rhinoceros of such slender proportions that Jourdan gave it the specific name of *elegans*. These tandem-horned animals were defended by a horn in the center of the nasals and a smaller horn in the center of the forehead. As first found in the Middle Miocene of France, they are small and of slender proportions, hardly larger than tapirs; those known as *Rhinoceros steinheimensis*, found in the Upper Miocene of Steinheim, Westphalia, Prussia, assume a little larger size; they appear somewhat larger still in the race known as Schleiermach's rhinoceros of the Lower Pliocene of Eppelsheim. Their first appearance in southern Asia is in the 'flat-nosed' rhinoceros, *Rhinoceros platyrhinus*, of the Lower Pleistocene deposits of India. Like all rhinoceroses these animals were first described as belonging to the genus *Rhinoceros*, but they really were profoundly different from the Indian Rhinoceros, to which alone the generic name *Rhinoceros* properly applies. As observed in Sumatra, they are persistently primitive animals, and probably inhabited during the geologic past, as they still do at present, the deep recesses of forests. Such protected environment is never favorable to rapid evolution but rather to persistence of type: for example, the forest-living okapi of central Africa today is far more primitive than its remote relative, the plains-living giraffe, which is exposed to enemies on every side.



This is the two-horned, hairy-eared rhinoceros of eastern Bengal, known as *Rhinoceros lasiotis*. Its tandem horns clearly distinguish it from the unicorn rhinoceros of Nepal and relate it to the rhinoceros of Sumatra. It is now very rare

These forest-living Ceratorhines were nevertheless widely distributed in past time: they were quite abundant in central India, the present region of the Siwalik Hills, in late Pliocene or early Pleistocene times, and we trace them westward again along the north shores of the Mediterranean in the slender-nosed Ceratorhine (*Ceratorhinus leptorhinus*), which is represented by numerous remains from near Montpellier (Hérault), France. There is also the long, slender-limbed Etruscan Ceratorhine (*C. etruscus*) from the Upper Pliocene, a geologic period when these animals, favored by a genial climate, occurred in the very broad forest belt extending from the east coast of England, where they are abundant in the Upper Pliocene Red and Norwich Crags, southward and eastward across southern France and northern Italy to distant India.



This beautiful drawing of the Asiatic rhinoceros, *Rhinoceros unicornis*, which appeared in Philip Lutley Sclater's Memoir of 1875 on the rhinoceroses, exhibits the broadly overlapping dermal folds which completely protect this animal from its enemies, a defensive adaptation interpreted by Albrecht Dürer in 1515 as shown on page 210

V. THE TYPICAL SINGLE-HORNED RHINOCEROSES OF ASIA

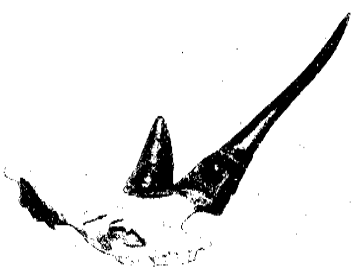
The consideration of the fifth group brings us back to the beginning of this article, namely, to the typical Asiatic rhinoceros, *R. unicornis*, a very powerful animal which is nearing extinction, but still survives in the forests of Nepal in northern India, where the Faunthorpe Expedition has recently secured a fine group for the American Museum. A related form occurs in the Islands of the East Indies in the species *R. sondaicus*. No representatives of these true Indian rhinoceroses have ever been found in Europe, or in Africa, or in the remote parts of the East Indies, or in fact anywhere except in southern Asia; none of them ever came over to North America; they appear to be exclusively Asiatic in their distribution.

The past geologic history of the true Indian rhinoceroses is rather obscure, for they are not found in any of the more ancient fossil beds of the Siwaliks, India, but appear with relative suddenness near the summit of the Siwaliks in the form of two species known as *R. sivalensis*, the rhinoceros of the Siwaliks, and *R. palæindicus*, the ancient rhinoceros of India. Of the two surviv-

(Right) Side view of the pointed-lipped 'black' rhinoceros, a browser of the central African plateau. After photograph by Jenness Richardson

(Left) Front view of the square-lipped 'white' grazing rhinoceros of the Lado district, Africa. After photograph by Herbert Lang

ing species the giant animal or typical *Rhinoceros unicornis*, with its longer crowned grinding teeth, is a *grazer*, preferring the grassy savannas of Nepal, whereas the smaller rhinoceros of India, known as *R. sondaicus*, is



White rhinoceros skull in the American Museum, brought to England by a missionary, the Rev. John Campbell, in the year 1815; preserved in the Museum of the London Missionary Society until 1867; in 1902 purchased from Cecil Graham by J. Pierpont Morgan and presented to the American Museum; described in a letter of 1821 as follows: "The head in the missionary museum supposed to be the head of the unicorn, appears to belong to a species of Rhinoceros previously unknown in this country."

chiefly a *browser*, its grinding teeth being shorter as in all browsers. Both fossil and living species exhibit a skull with a forwardly inclined occiput; the top of the skull is absolutely concave and hornless in the middle of the forehead, whereas the nasals are armed in the middle portion with a bony rugosity to support the great anterior horn, but beyond this the nasals are smooth and terminate in pointed extremities. Thus we readily distinguish the nasal horn region of the true rhinoceroses from the same part of the skull in either the Sumatran type or the next type to be considered, the African.

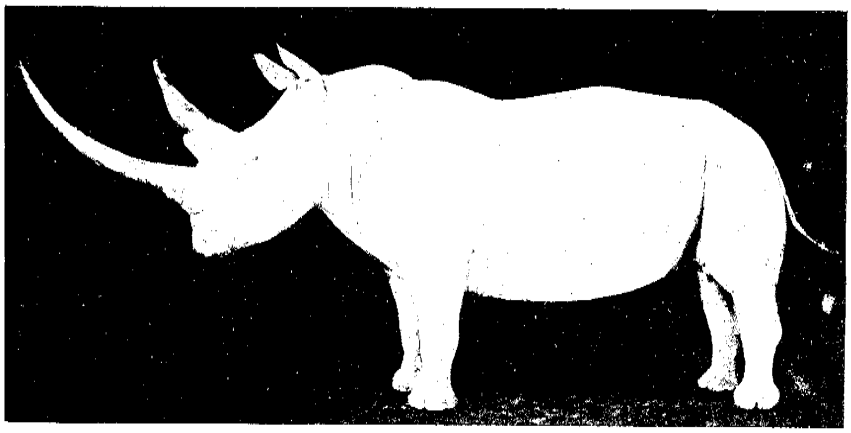
VI. THE RHINOCEROSES WITHOUT CUTTING TEETH, OR ATELODINES, OF AFRICA AND EUROPE

The two living African rhinoceroses, 'black' and 'white,' are the sole survivors of a group of African-European animals readily distinguished from the other groups by the fact that both the upper and lower cutting teeth are vestigial or wanting, evidently because these animals gave up the use of these teeth very early in geologic time and substituted very broad grazing lips like those of the white rhinoceros for the narrow pointed browsing lips that are characteristic of the black rhinoceros. They did not need the cutting teeth as offensive or defensive weapons because the top of the skull was provided with two large, strongly developed horns placed upon the nasals and frontals, the frontal horn

both in the white and the black rhinoceros being the most powerful fighting weapon of the kind developed in any quadruped.

The ancestors of these animals, known as *Ceratotherium pachygnathum*, suddenly appear in the famous Lower Pliocene quarries of Pikermi, Greece. It seems probable that these 'thick-jawed' rhinoceroses came to Greece from Africa accompanied by numerous antelopes and giraffes, which also appear to be of African origin. A fine skull and skeleton of the thick-jawed rhinoceros of Pikermi was described and figured in 1862 by the veteran French palæontologist, Albert Gaudry; even in the skull of the young of this animal there are indications of a very large frontal horn and the nasal bones are very broad and thick at their extremities, adapted to a large nasal horn; the jaws beneath are reduced and the front teeth, which are extremely small, soon disappear. This animal, like the black rhinoceros of Africa, was a browser or shrub eater.

This thick-jawed rhinoceros of the Greek Pliocene resembles so closely the great woolly rhinoceros of the Ice Age of northern Eurasia, described by Blumenbach in 1799 as *R. antiquitatis*, the rhinoceros of antiquity, that Duvernoy believed that the Siberian and Grecian specimens belonged to the same species, and Albert Gaudry remarked in 1862 that this conclusion was very natural because the limb bones are so similar.



Mounted specimen of the superb example of the 'white' rhinoceros, *Ceratotherium simum*, collected by the American Museum Expedition of 1909–15 under Messrs. Lang and Chapin in the Lado district, central Africa, northeast of the Congo forests. Mounted by Mr. James L. Clark for the Roosevelt African Hall of the American Museum

The writer verified these observations by comparison of all the specimens of the black, of the white, of the thick-jawed, and of the woolly rhinoceros, and came to the conclusion that the woolly rhinoceros was intermediate in structure between the black and the white. The white rhinoceros of Africa (*C. simum*) is the largest living type. It has a square upper lip with very broad nasal bones, the horn rugosities being carried out to the very extremity of the nasals so that the horn pitches forward and its cranial resemblance to the thick-jawed rhinoceros is remark-

able. The black rhinoceros (*D. bicornis*), on the other hand, has a pointed prehensile upper lip with the somewhat more pointed nasals associated with this narrow snout, yet the horns are carried also to the very extremity. The writer's conception of the woolly rhinoceros, which is shown in Mr. Charles R. Knight's restoration (page 223), indicates an intermediate structure.

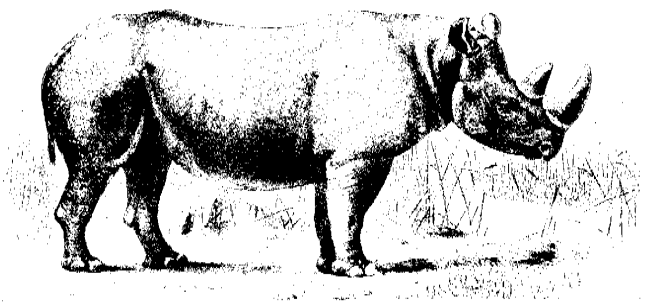
These animals were mainly African and European in their migrations but appear to have wandered as far east as Maragha, Persia. Their favorite habitat during the Ice Age was the cold steppes and tundras of the North to which they became perfectly adapted through the development of a thick undercoating of woolly fleece of a golden-brown color, a specimen of which is preserved in the St. Petersburg Museum.

The woolly rhinoceros has been found all over Europe, but to the east its geographical range may have been limited by the largest and most formidable of the rhinoceroses, namely, the great single-horned Elasmotheres, which exceeded all other rhinoceroses in size with the exception of the recently discovered Baluchitheres.

VII. THE ELASMOTHERES OF THE TUNDRAS AND STEPPES OF PLEISTOCENE EUROPE

A peculiarity of these Elasmotheres which gives them their name is the wavy enamel of the teeth, which folds in and out in thin plates, the designation *Elasmotherium* (e.g., ἐλασμός, thin plate, and θηρίον, wild beast) being applied by the Russian naturalist, Fischer, in 1808 to the first specimen discovered, namely, *E. sibiricum* from the Pleistocene in the vicinity of Miask, Siberia. During the Ice Age these animals were driven as far south and east as central Europe.

They differ from all other horned rhinoceroses in the entire absence of any trace of a horn upon the nasals and in the development in the middle of the forehead of a gigantic bony prominence



The 'black' rhinoceros, known as *Diceros bicornis*, of the central African plateau; figured by Philip Lutley Sclater in 1875. This animal is reproduced to the same scale as the rhinoceroses represented on pp. 215, 217, 218, 219, 221; it therefore represents a rather small individual of this powerful animal, which is none the less considerably inferior in size to the 'white' rhinoceros (page 221)

which may have borne a huge median horn, or may have supported merely a thickening of the epidermis. It is possible, as observed by the writer, that this median horn may have evolved out of the inconspicuous median rugosity found by him on the top of the *Aceratherium incisivum* skull in the Museum of Darmstadt. The ancestry of the Elasmotheres, however, remains an open question upon which some light will probably be thrown by the fossil-hunting parties now working in northern Asia. Suffice it to say that the Elasmothere skull surpasses in size that of the gray-white rhinoceros of Africa but is still far inferior in size to that of the Baluchitheres.

The woolly rhinoceros, described by Blumenbach as *Rhinoceros antiquitatis*, now known as *Ceratotherium antiquitatis*. This scene is in the steppe period or climate of Postglacial time in northern France. During this period the woolly rhinoceros was portrayed by artists of the Crô-Magnon race in several drawings or etchings, from which this restoration was made. Drawn by Charles R. Knight under the direction of the author

VIII. BALUCHITHERES, THE GIANT HORNLESS RHINOCEROSES OF WESTERN AND CENTRAL ASIA

Such was the general state of our knowledge of the great family of rhinoceroses and their migrations until the year 1911, when Clive Forster Cooper of Cambridge, England, formerly a student in the American Museum, made his expedition into the Bugti Hills of eastern Baluchistan on the borders of India. Here he discovered two kinds of aberrant rhinoceroses,—first, a small animal which he named *Paraceratherium*, that is "akin to *Aceratherium*," represented by fairly complete skulls and lower jaws; second, evidence of an animal of enormous size the kinship of which he was unable to determine with certainty although from the first he suspected its relationship to the rhinoceroses; this animal he named after the region of its discovery *Baluchitherium*, the wild beast of Baluchistan, and the specific name *osborni* he assigned to it in honor of the present writer.

In a series of papers Cooper described the perfectly gigantic neck bones of this animal and parts of the foot and limb bones exceeding those of the elephants in size. Finally, in February, 1923, he concluded that *Baluchitherium*

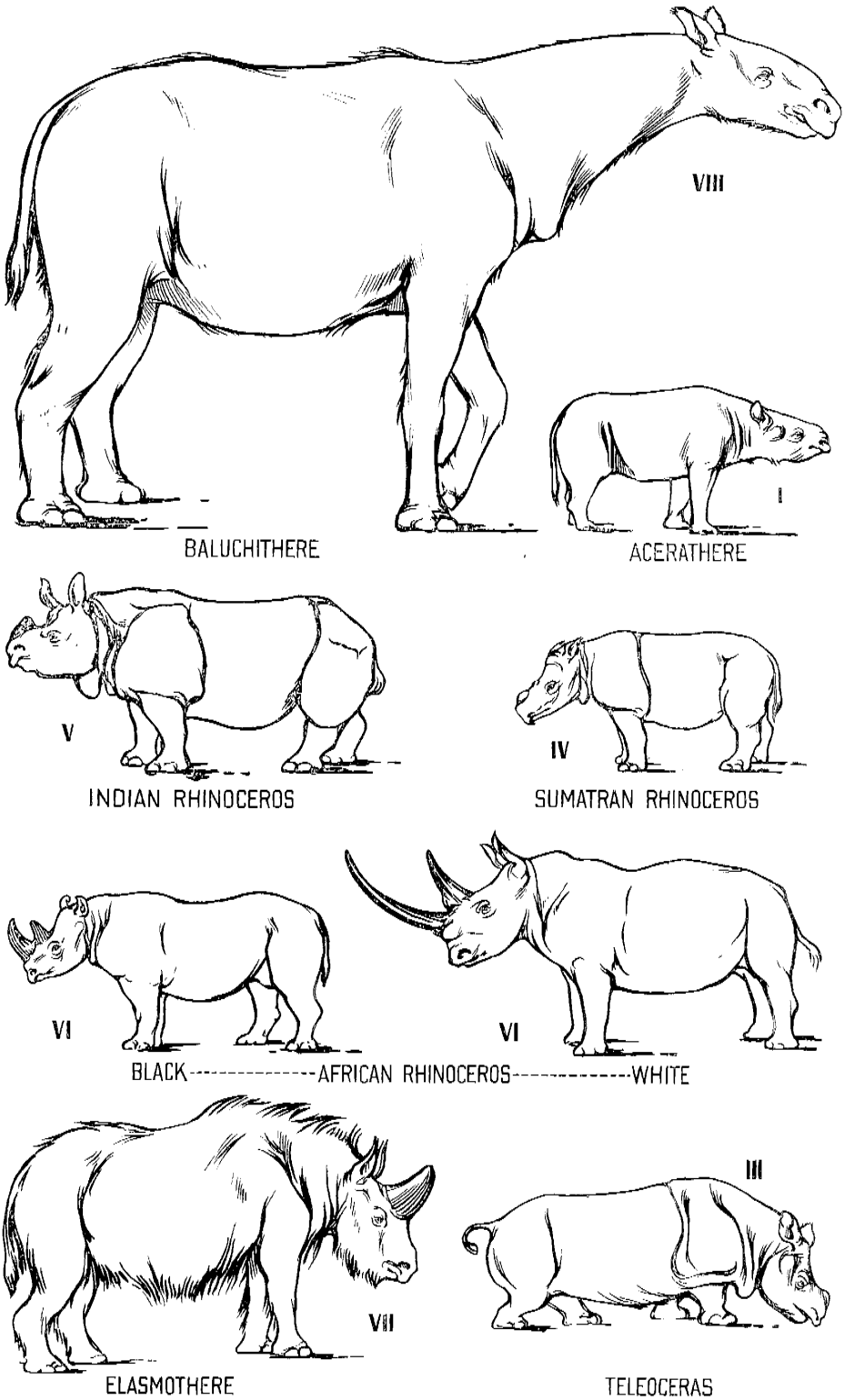
may be described as the only known member at the end of a series of odd-toed ungulates, extremely tall-footed, probably long-headed, of primitive kinship to the rhinoceroses, somewhat masked by adaptation to weight, the direct line of ancestry being as yet unknown. This excellent conjecture of 1923 was partly based on the discovery by the Russian palæontologist Borissiak in Turgai, northern Turkestan, of a gigantic animal to which he gave the name *Indricotherium asiaticum*. Borissiak was fortunate enough to discover not only parts of the skeleton but well-preserved grinding teeth, which he immediately observed were like those of some of the large Oligocene Aceratheres above described. It was found that the Turkestan animal is very closely similar in size to that from Baluchistan so that Forster Cooper and Borissiak together added to the rhinoceroses of the world a new animal of gigantic size without being able to determine precisely its affinities to the other rhinoceroses.

This was the condition of our knowledge when the Third Asiatic Expedition left Kalgan on April 21, 1922. The first giant bones were discovered on the journey north toward Urga near Iren Dabasu, consisting of an enormous heel bone (*os calcis*) and other bones of the foot and wrist which were recognized at once as comparable in size to those of *Baluchitherium*. The second and most important find was made on August 5, 1922, near Loh in the Tsagan Nor Basin: this was a skull with portions of the jaw, the lower end of the shoulder bone, and the humerus. The skull and jaw were about fifty feet apart but probably belonged to the same individual. About a quarter of a mile distant were found the remains of a third specimen.

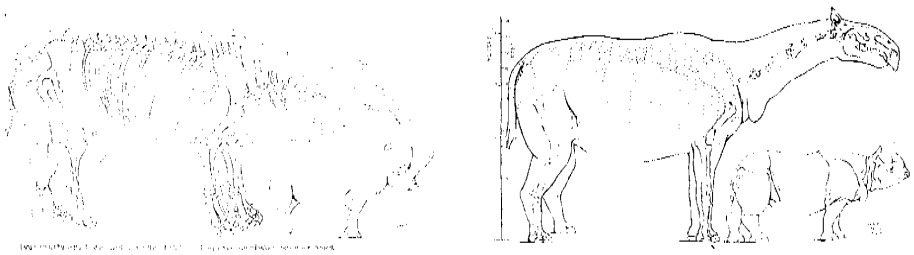
Fortune favors the brave and the well prepared: about half the skull was found in large sections, the remainder was weathered into hundreds of fragments. From an examination of the larger pieces and the 360 fragments of bones and teeth which belonged to this remarkable specimen it was recognized at once that it might be possible to reconstruct the skull. These larger and smaller parts were excavated by Mr. Walter Granger with the skill and cunning which comes from twenty-five years' experience in the western badlands of the United States. The packing of this skull, its transportation across the desert of Mongolia, its preservation from bandits and from the unpaid Chinese soldiery, its journey to Peking, thence to the nearest port, and finally its safe carriage to the American Museum, where it arrived absolutely uninjured on December 19, 1922—these are among the great events of palæontologic history.

It required three months of the most skilful work in the Museum laboratories to prepare and restore the skull and jaws, as they are now shown in the photograph on page 227. From the first the animal seemed incredibly large; it was hard to believe that it was actually a reality; it immediately justified the estimate of its original discoverer, Forster Cooper, that it was probably the largest land animal known, taller than any of the existing elephants, dwarfing the existing or fossil rhinoceroses, equaling or exceeding in height the most lofty of the extinct elephants.

The two restorations which are reproduced on page 226, to be known as the first and second restorations, show the successive attempts to portray its size. The first restoration, which was hurried forward soon after the



RHINOCEROSES, LIVING (FACING LEFT), EXTINCT (FACING RIGHT)
Baluchitherium grangeri (VIII) towers over all of its relatives (I–VII)



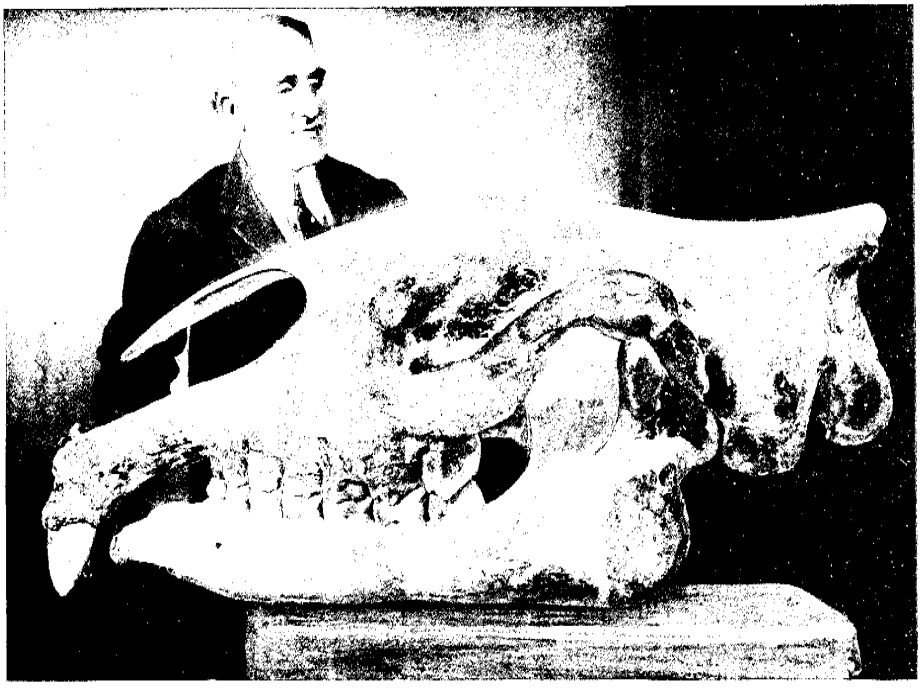
To the left is the first restoration of *Baluchitherium grangeri*, estimated as 12 feet in height at the withers, a massive animal towering above the existing 'white' rhinoceros placed beneath its head and neck.

To the right is the second restoration of *Baluchitherium grangeri*, estimated as 13 feet in height at the withers, towering above the Indian rhinoceros placed beneath its head and neck. In the second restoration the bones thus far discovered are represented in solid lines, the conjectural bones in dotted lines. The body outline in both restorations is highly conjectural

great skull arrived, represents a very massive animal proportioned somewhat like the rhinoceros, of a shoulder height of 12 feet, making the gray-white rhinoceros of Africa appear like an infant. The second restoration, dated March 24, 1923, prepared under the direction of the writer, changed the proportions considerably, giving the animal the greater height of 13 feet at the shoulders and a relatively longer neck. The head reached a normal height of 14 feet above the ground but readily attained a height of 16 feet when the creature stretched its neck. In this second restoration the body is relatively shortened, the limbs relatively lengthened. With the able assistance of Dr. William K. Gregory, the writer calculated with great care the body proportions of *Baluchitherium* as compared with those of the white rhinoceros, of the black rhinoceros, of the Oligocene Aceratheres, of the short-footed Teleoceriue rhinoceroses, and finally of a gigantic horse bred in Kansas that attained a height of 18¼ hands, or 6 feet, 1 inch. It was proved that *Baluchitherium* surpassed both the living African and Indian elephants in height because while its limb bones are equally long, its foot bones are relatively longer and more stilted, as observed by Forster Cooper; consequently it is a rhinoceros on stilted limbs with extremely long neck, proportioned as in the horse but of massive size.

With this elevated body form and massive neck, the head, gigantic as it at first appeared, diminishes in relative size, although far exceeding that of any existing mammal in absolute size. This very long narrow head placed at the end of an extremely long neck and provided with short grinding teeth, like those of the browsing rhinoceroses we have described, namely, the Aceratheres, the black rhinoceros, the Sumatran rhinoceros, and the Sondaican rhinoceros, compels us to believe that *Baluchitherium* was a gigantic browser, feeding upon leaves and twigs, buds and blossoms. It was certainly not a ground browser, like the black rhinoceros, whose head is carried very close to the ground, but more probably a tree browser, comparable to the giraffe and okapi among the even-toed animals and to certain other tree browsers among the odd-toed ungulates or hoofed animals.

In the third restoration (page 208), executed under the writer's direction by Mrs. E. Rungius Fulda, the *Baluchitherium* is represented as a gigantic tree browser stalking about among the fertile savannas of ancient Mongolia, in Upper Oligocene or Lower Miocene times, well protected from its enemies



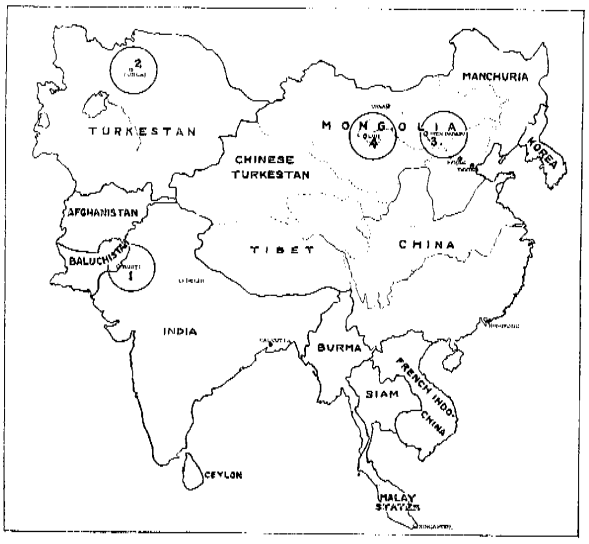
Skull of *Baluchitherium grangeri* as finally restored and ready for casting on May 1, 1923, in the laboratory of the department of vertebrate palaeontology of the American Museum, by Otto Falkenbach of the department staff. This photograph gives an idea of the gigantic size of this skull, which is nevertheless relatively small as compared with the bones of the skeleton, as shown in the two restorations on page 226

by its very great height and by its power of locomotion, surpassing in speed that of the elephants and of the swiftest rhinoceroses, living or extinct.

The writer anticipates that when the complete fore limb and shoulder blade of this giant animal become known, it will be found that the shoulders were well elevated above the hips because it generally happens in the course of evolution that the anterior part of the body of tree browsers is harmoniously elevated with the elongation of the neck. It is obvious that tree-browsing animals of increasing height of body and of shoulder, of a generally increasing length of neck, and of increasing stretch of prehensile lips adapted to feeding on the herbage of the higher branches of trees would up to a certain point become increasingly tall through the process of natural selection and survival of the fittest, which in our opinion is the best explanation of the long neck of the giraffe.

Finally, what is the relationship of the Baluchitheres to the other rhinoc-

eroses? Are they simply giant Aceratheres? This conjecture would at first appear to be probable from the close similarity in size and proportions of the skull and the absolute hornlessness of the skull, for both the frontal and nasal bones are perfectly smooth without any trace of a rugosity. But the very powerful superior tusks present a difficulty in the acceptance of this theory; there is nothing resembling the *Baluchitherium* tusks in any other member of the rhinoceros family in which the remaining upper incisors are either short-crowned or vestigial but never tusklike or pointed. In *Baluchitherium* they are veritable tusks, shaped like canines or eyeteeth, terrible weapons of offense and defense, and wielded by a skull of surpassing size and weight and by a neck of gigantic proportions.



Map of central and southwestern Asia showing the type localities of (1) *Baluchitherium osborni* type, eastern Baluchistan; (2) *Indricotherium asiaticum* type, near Turgai, northern Turkestan; (3) *Baluchitherium grangeri* ref., near Iren Dabasu, southeastern Mongolia; (4) *Baluchitherium grangeri* type, near Loh, central Mongolia

NOTES FOR THE READER AND THE STUDENT

The reader who desires to follow up this subject is referred to Dr. Philip Lutley Sclater's Memoir of 1875 "On the Rhinoceroses Now or Lately Living in the Society's Menagerie," which appeared in the *Transactions of the Zoological Society of London;* also to the Memoir of Henry Fairfield Osborn (1898) entitled *The Extinct Rhinoceroses* or to his *Bulletin* (1900) on "The Phylogeny of the Rhinoceroses of Europe." Many recent papers of great interest have been published, especially on the woolly rhinoceros of Starunia by Dr. E. Niezabitowski. On the Baluchitheres the chief papers are by C. Forster Cooper and A. Borissiak, cited by the present writer in the first description of the skull of *Baluchitherium grangeri* in American Museum *Novitates* No. 78. In all 264 titles of papers and memoirs relating to extinct and living rhinoceroses are contained in the Osborn Library, a branch of the main Library of the American Museum.

The reader whose interest may have been aroused by this article will find in the American Museum the finest collection of fossil rhinoceros remains that has ever been brought together, including a superb collection of fossil and recent skulls from all parts of the world, three beautifully mounted specimens of the gray-white rhinoceros collected in the Congo region by the Lang-Chapin Expedition, and especially a series of mounted fossil skeletons of Aceratheres, of Diceratheres, and of the *Telmoceras*, to which will shortly be added a diminutive *Trigonias* from Colorado. The *Elasmotherium* skull alone is represented by a cast; all the other skull types are originals including that of the recently finished skull of *Baluchitherium grangeri*. The interested visitor to the Museum should also see representatives of other main branches of rhinoceros affiliation known as the aquatic Amynodonts, which like the Aceratheres roamed through Europe and across Asia to North America; also the cursorial rhinoceroses or Hyracodonts which were confined to North America.