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BALUCHITHERIUM GRANGERI, A GIANT HORNLESS RHINOCEROS FROM MONGOLIA

BY HENRY FAIRFIELD OSBORN[1]

In previous communications on the rhinoceroses (Rhinoceros Contributions 1 to 11), Osborn separated six distinct phyla or subfamilies. The remarkable discoveries by Clive Forster Cooper in Baluchistan, by A. Borissiak in north Turkestan, and by Walter Granger of the Third Asiatic Expedition in southeastern and central Mongolia, indicate the existence of a seventh subfamily which we may term **Baluchitheriinæ**, if the generic name proves valid. At present our knowledge rests on the following materials:

BUGTI HILLS, Chur-lando, Baluchistan. Cooper Collection, British Museum.

Paraceratherium bugtiense Cooper, December 1911. Fairly complete skulls and lower jaws of about the size of a large rhinoceros, simple aceratherine molars, abnormal lower incisors.

Thaumastotherium osborni Cooper, October 1913, changed to *Baluchitherium osborni* Cooper, November 1913. Fragmentary skeletal remains found in close proximity to *Paraceratherium*, including neck vertebræ, foot and limb bones of elephantine size.

TURGAI, a province of north Turkestan. Discoveries by A. Borissiak, published 1915–1918.

Indricotherium asiaticum Borissiak, 1916. Teeth, skull, and skeletal remains, occurring *in situ* and resembling both *Paraceratherium* and *Baluchitherium*.

Epiaceratherium turgaicum Borissiak, 1918.[2]

LOH, central Mongolia, Third Asiatic Expedition Collection, 1922. Associated skull and skeletal remains similar in size to the type of *Baluchitherium osborni*.

Baluchitherium grangeri, new species. Type, nearly complete skull and jaws (Amer. Mus. 18650) associated with parts of vertebræ and of limb bones, as described in the present bulletin.

IREN DABASU, southeastern Mongolia. *Baluchitherium* ref., calcaneum and other fragments of skeleton.

DISCOVERY OF SKULL AND SKELETON IN MONGOLIA, 1922

The party left Kalgan on April 21, 1922. (1) The first *Baluchitherium* material was discovered by Dr. Charles P. Berkey on the journey

[1]Contribution No. 8, Asiatic Expeditions of The American Museum of Natural History. Twelfth Contribution on the Evolution of the Rhinoceroses. See Bibliography of H. F. Osborn, 1916, p. 21.

[2]The genus *Epiaceratherium* was founded on the species *Epiaceratherium bolcense*. See Abel, 'Kritische Untersuchungen über die paläogenen Rhinocerotiden Europas,' Abh. k. k. geol. Reichsanst., XX, Heft 3, p. 20.

north towards Urga, near Iren Dabasu; this consists of a large calcaneum and other tarsal or carpal bones, more or less fragmentary, bearing the field number "Third Asiatic Exped. 37," to which has been assigned the catalogue number "Amer. Mus. 18651." (2) The second and most important find was made on August 5, 1922, near Loh, in the Tsagan Nor Basin, Hsanda Gol Beds; this includes a skull, portions of the jaws, and the distal end of a humerus, bearing the field number "Third

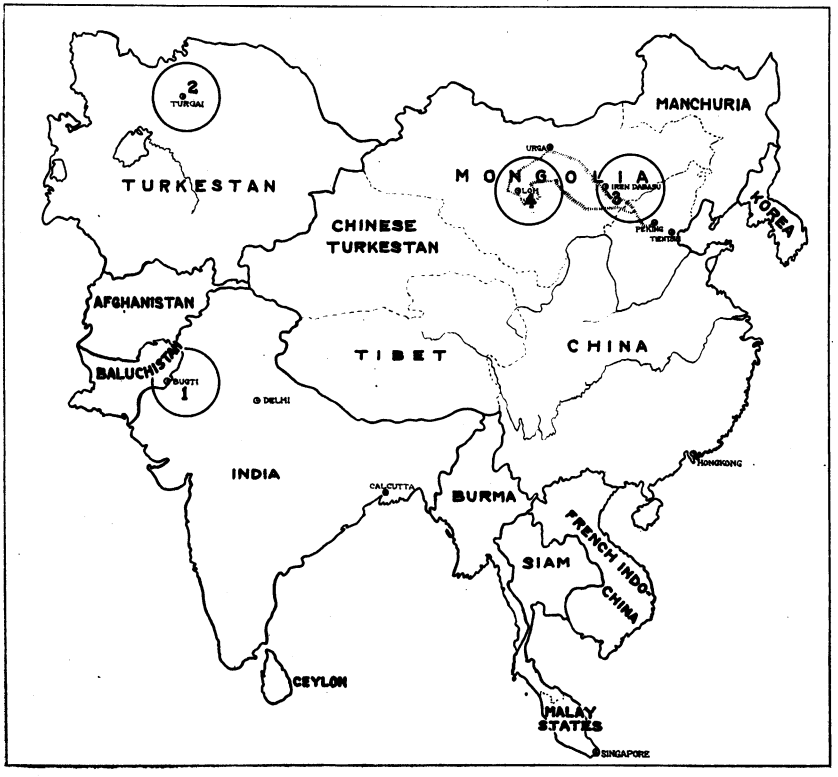

Fig. 1. Map of central and southwestern Asia showing the type localities of (1) *Baluchitherium osborni* type, eastern Baluchistan; (2) *Indricotherium asiaticum* type, near Turgai, northern Turkestan; (3) *Baluchitherium grangeri* ref., near Iren Dabasu, southeastern Mongolia; (4) *Baluchitherium grangeri*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

Asiatic Exped. 90," to which has been assigned the catalogue numbers "Amer. Mus. 18650, 18652." The skull and mandible were about fifty feet apart and probably belong to the same individual. This specimen is made the type of **Baluchitherium grangeri** described below. (3) The

humerus was found a quarter of a mile distant from the type and may or may not belong to the same individual, but probably to another individual. The American Museum catalogue references to the three specimens are as follows:

AMER. MUS. 18651	AMER. MUS. 18650	AMER. MUS. 18652
THIRD ASIATIC EXPED.	THIRD ASIATIC EXPED.	THIRD ASIATIC EXPED.
Calcaneum and other fragments of skeleton	Type skull and part of mandible	Distal end of humerus

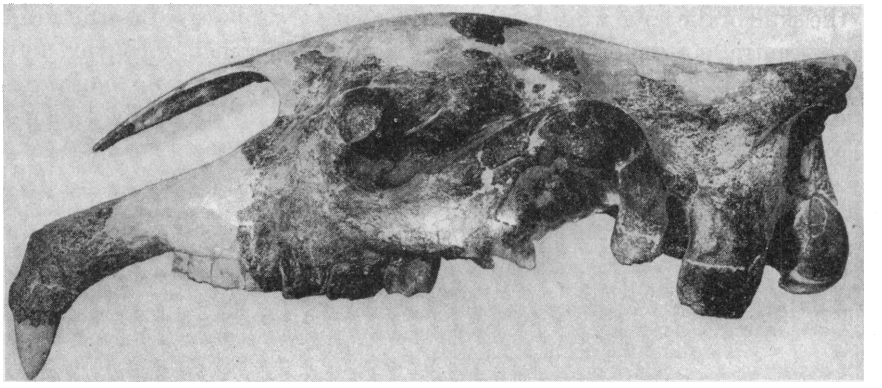

Fig. 2. Type skull of *Baluchitherium grangeri* as restored up to March 16, 1923. A portion of the jaw and of the right side of the skull is now being added for the skull and jaw cast. One-twelfth natural size.

GEOLOGIC AGE.—The *Baluchitherium* calcaneum (Amer. Mus. 18651, Fig. 8 of this article) is from the Houldjin formation near Iren Dabasu, an upper member of the Gobi series containing at the base rhinoceros gravels five feet in thickness; the Houldjin beds were correlated by Granger and Berkey (Amer. Mus. Novitates No. 42, August 7, 1922, p. 4) as of Miocene or more recent age, more recent than the underlying Irdin Manha formation, which is regarded as of Oligocene age. Of the same age is the equivalent formation in the Tsagan Nor district near Loh, several hundred miles to the west, from which the type of *Baluchitherium grangeri* was obtained. This formation has been named the Hsanda Gol formation. Borissiak placed the *Indricotherium asiaticum* zone as far down as the Middle Oligocene; it is regarded by Granger and Berkey as more probably of middle or late Miocene age, since it contains (*op. cit.*, p. 4) a rhinocerid, a large carnivore, an artiodactyl of the size of a Virginia deer, and a tortoise of large size, in addition to the enormous perissodactyl known as *Baluchitherium*.

Baluchitherium grangeri, new species

This remarkable type specimen, named in honor of Walter Granger, head of the palæontologic division of the Third Asiatic Expedition under Roy Chapman Andrews, was found as indicated in the map (Fig. 1, 4) and described above.

DESCRIPTION OF THE TYPE SKULL

The skull of *B. grangeri*, while of enormous size, as shown by comparison (Fig. 3) with that of the type of *Aceratherium incisivum* Kaup and the skull of the large white rhinoceros, is relatively primitive in structure; the central portion of the forehead is prominently arched or convex, and the bones preserved (Fig. 3*A*) show that there is absolutely no indication of either a frontal or nasal horn. The proportions are decidedly dolichocephalic, as indicated by the following chief measurements:

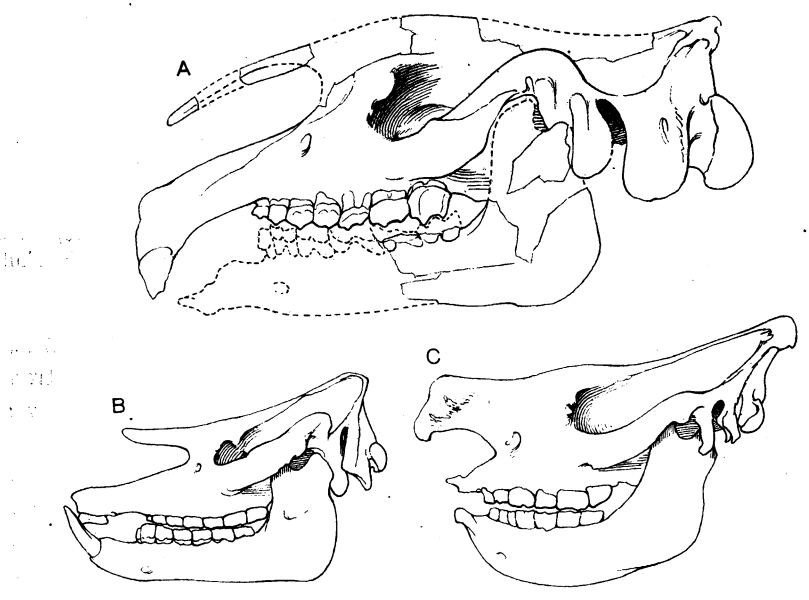

Fig. 3. Comparative view of the skulls of: *A*, *Baluchitherium grangeri* type; *B*, *Aceratherium incisivum* type, from the Darmstadt collection; *C*, *Ceratotherium simum* (Amer. Mus. 1142). One-sixteenth natural size.

Length of *Aceratherium incisivum* type skull, from premaxillaries to condyles	694 mm.
Length of *Ceratotherium simum* skull, from premaxillaries to condyles	728

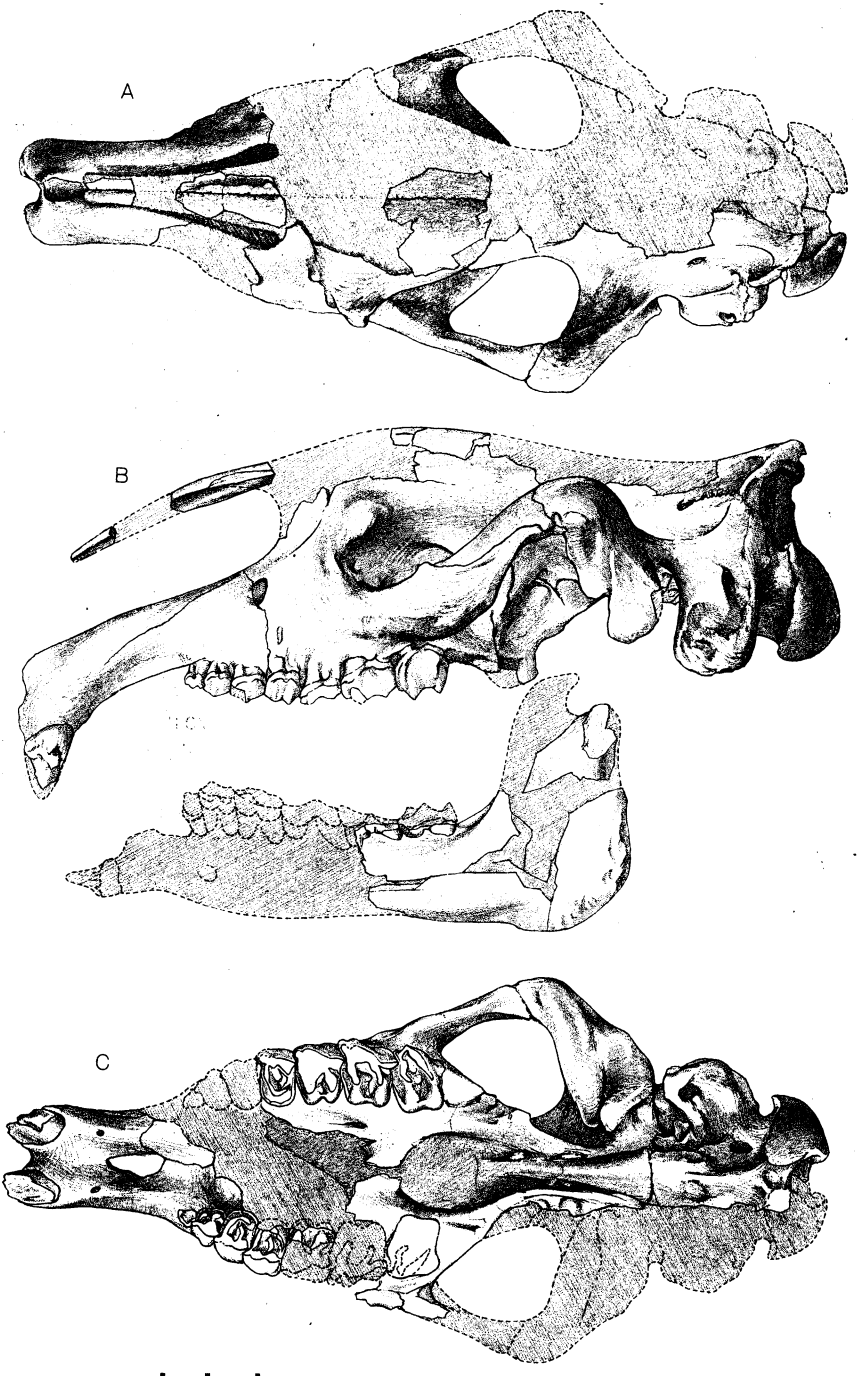

Fig. 4. *A*, Top view of skull of *Baluchitherium grangeri* type, to show the original and restored portions; the original portion including parts of the frontals, the middle portion of the nasals and the tip of the nasals. *B*, Side view of the skull and jaws of the same; part of the fragments of the jaw, reversed from the other side; anterior portion of the jaw restored from *Paraceratherium bugtiense*, after Forster Cooper, Pl. x, fig. 1, highly conjectural. *C*, Palatal view of same showing the simple and primitive characters of the premolar teeth. All figures one-twelfth natural size.

Length over all of *Baluchitherium grangeri* type, from front of premaxillary symphysis to back of occipital condyles..... 1286 (4 ft. 3 in.)
Greatest zygomatic width of *B. grangeri* type, anterior to glenoid fossæ..... 614 (2 ft. ⅛ in.)

Consequently, the zygomatic-cephalic index of the type of *Baluchitherium grangeri* is 47.7; the zygomatic-cephalic index of the much smaller *Aceratherium incisivum* type skull is 54.3; the zygomatic-cephalic index of the massive *Ceratotherium simum* skull is 46.7.

The proportions, length, and breadth of the *B. grangeri* type skull are extremely close to those of the *Cænopus* (*Aceratherium*) *occidentalis* skull of the American Oligocene, namely:

Cænopus occidentalis, zygomatic-cephalic index =48.5
Baluchitherium grangeri, zygomatic-cephalic index =47.7
Rhinoceros indicus, zygomatic-cephalic index =58.0
Ceratotherium simum, zygomatic-cephalic index =46.7
Aceratherium incisivum type, zygomatic-cephalic index =54.3

This is a primitive Eocene and Lower Oligocene form of skull grown large. In profile it nearly resembles the primitive skulls of several Eocene perissodactyls in several independent lines of perissodactyl descent, also of several Lower Oligocene aceratheres. The reasons are obvious: (1) the greatly enlarged second incisor, I^2, functions as a defensive tusk or canine; (2) the animal was completely protected by this as well as by its rapidly increasing height, so that it probably towered over all the mammals of the period; with its very thick rhinocerotic skin, it was safe from attack; (3) with an entire absence of horns there is no secondary cranial modification to support the powerful nasal and frontal horns, as in the ceratorhines and African rhinoceroses.

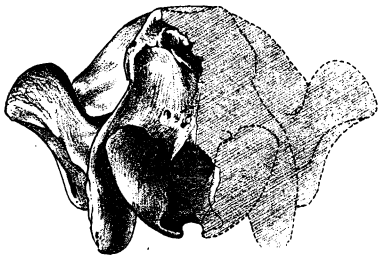

Fig. 5. Occipital view of the skull of *Baluchitherium grangeri* type (Amer. Mus. 18650), to be compared with occipital views of the Oligocene aceratheres. One-twelfth natural size.

The amazing size and power of the skull is none the less manifested in the condyles, which are enormous as compared with those of *C. simum* and as large as in any species of proboscidean. The occipital condyles of *Baluchitherium grangeri* exceed in both diameters the anterior facets of the atlas in Forster Cooper's specimen; it follows that the skull of *B. grangeri* belongs to an animal with even larger and more massive cervicals than those described and figured by Forster Cooper in *B. osborni*. The

seven superior grinding teeth, P^1–M^3, are of the brachyodont, short-crowned, browsing type and parallel, in the very retarded development of the superior crests or metalophs of the premolar teeth, those in the American aceratheres described by Osborn as *Aceratherium platycephalum* (see Osborn, 1898, p. 140, Pl. XIII, figs. 9, 10).

COMPARATIVE MEASUREMENTS IN MILLIMETERS

	Baluchitherium osborni	*Indricotherium asiaticum*	*Baluchitherium* OF IREN DABASU	*Baluchitherium grangeri* OF LOH
SKULL, length condyles to symphysis	....	....	....	1286
Zygomatic width	....	....	....	614
Condylar width	....	....	....	306
HUMERUS, length between articular surfaces	840	930	....	....
Proximal width	376(?)	....	....	....
Distal width	230	....	....	287
ULNA	....	1200	....	....
FEMUR, length between articular surfaces	1200	1230	....	....
Proximal width	300(?)	....	....	....
Distal width	190	....	....	....
TIBIA, length between articular surfaces	790	860	....	....
Proximal width	250	....	....	....
FIBULA	....	....	....	....
CALCANEUM, max. length	....	....	324	....
TUBER CALCIS max. width	....	....	148	....
ASTRAGALUS	....	....	....	....
Max. height	144est.	....	....	....
Max. width	195	212	....	....
METATARSAL III, max. length	....	510	....	....
METACARPAL III, max. length	440	545	....	....
METACARPAL IV, max. length	375	....	....	....
RIB	....	660	....	....
ATLAS (1ST CERVICAL)	....	....	....	....
Max. width	475	....	....	....
Width of ant. condylar surfaces	280	....	....	....
Extreme length of wing	240	....	....	....
3RD CERVICAL	....	....	....	....
Extreme width	400	....	....	....
Extreme length	420	....	....	....
6TH CERVICAL	....	....	....	....
Max. width	460	....	....	....
Max. length	300	....	....	....

SPECIFIC DENTAL CHARACTERS OF *Baluchitherium grangeri*.—Premolar crests retarded in development: First premolar a small simple tooth. Second premolar, small, protoloph distinct; also with large postero-internal tetartocone and rudimentary metaloph. Third pre-

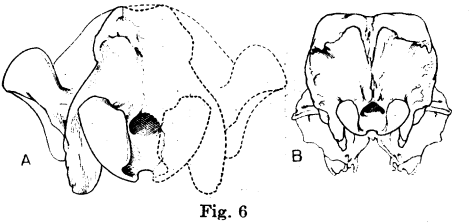

Fig. 6

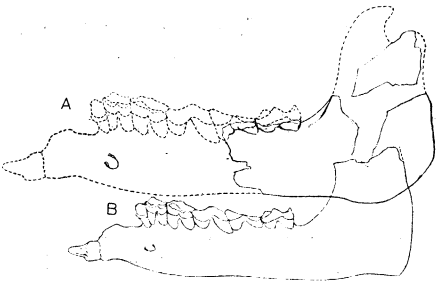

Fig. 7

Fig. 6. Occipital view of: *A*, *Baluchitherium grangeri* type; *B*, *Ceratotherium simum*, an unusually large skull in the American Museum (Amer. Mus. 1142). Both figures one-sixteenth natural size.

The *Baluchitherium* occiput is very similar to that of the Oligocene aceratheres of America, as figured by Osborn, 1898, Pl. XIX, namely, *A. trigonodum*, *copei*, *occidentale*, *tridactylum*.

Fig. 7. Lower jaws of: *A*, *Baluchitherium grangeri* type (Amer. Mus. 18650), as compared with *B*, *Paraceratherium bugtiense*, after Forster Cooper. The dotted restoration of the anterior portion of the *Baluchitherium grangeri* jaw is conjectural. Both figures one-sixteenth natural size.

molar with protoloph forming a long hook-like crest continuous with tetartocone; metaloph slender, not connected with tetartocone. Fourth premolar still larger, with very prominent metaloph curving (hook-like) into internal tetartocone; within this a slender metaloph. The premolar transformation in *B. grangeri* is shown in the type specimen (Fig. 4*C*). The fourth premolar is relatively wider than in *I. asiaticum*.

This kind of premolar transformation is different from that observed in the American Oligocene aceratheres, *A. occidentale* and *D. tridactylum;* it approaches *A. platycephalum* (compare Osborn, 1898, Pl. XIII, figs. 9, 10), but is more advanced. As compared with the premolar transformation in the European aceratheres (compare Osborn, 1900, p. 242, Fig. 8, "Evolution of the grinding teeth in the Aceratheriinæ"), it resembles most closely the condition observed in P^3, P^4 in *Aceratherium filholi* type, Lower Oligocene, Phosphorites, Quercy.

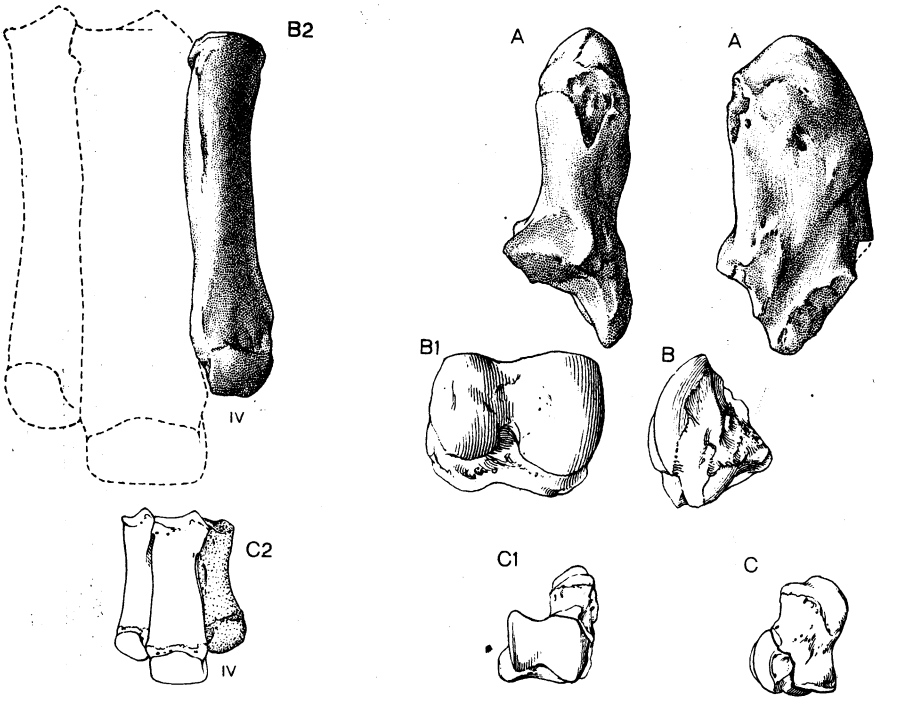

Fig. 8. Foot bones of: *B*, *Baluchitherium osborni*, and *A*, *Baluchitherium grangeri*, as compared with the corresponding foot bones of *C*, *Ceratotherium simum*. *A*, External, and *A*1, anterior views of the left calcaneum (Amer. Mus. 18651) found near Iren Dabasu. *B*, Internal, and *B*1, anterior views of astragalus, also *B*2, metatarsal IV, drawn after casts presented by the British Museum; cast Amer. Mus. 5210 (?metacarpal), and 5209 (astragalus). Corresponding astragalus and calcaneum united of *Ceratotherium simum* (Amer. Mus. 51862). *C*, External view; *C*1, anterior view; *C*2, anterior view of right fore foot. All figures one-eighth natural size.

Second Restoration of *Baluchitherium grangeri*[1]

The skeleton of *Baluchitherium* has been restored through careful comparison of four sets of measurements (p. 7), two given by Forster Cooper (1923) and Borissiak (1918), and two from specimens in the American Museum, one from Iren Dabasu, and one the type from Loh. These measurements are astonishingly uniform and indicate that the

[1]This restoration has been prepared under the direction of the writer with the coöperation of Dr. W. K. Gregory and Mrs. L. M. Sterling. The first restoration was drawn chiefly under the direction of Dr. W. D. Matthew by Mrs. E. Rungius Fulda and has been published in the magazine Asia, April 1923.

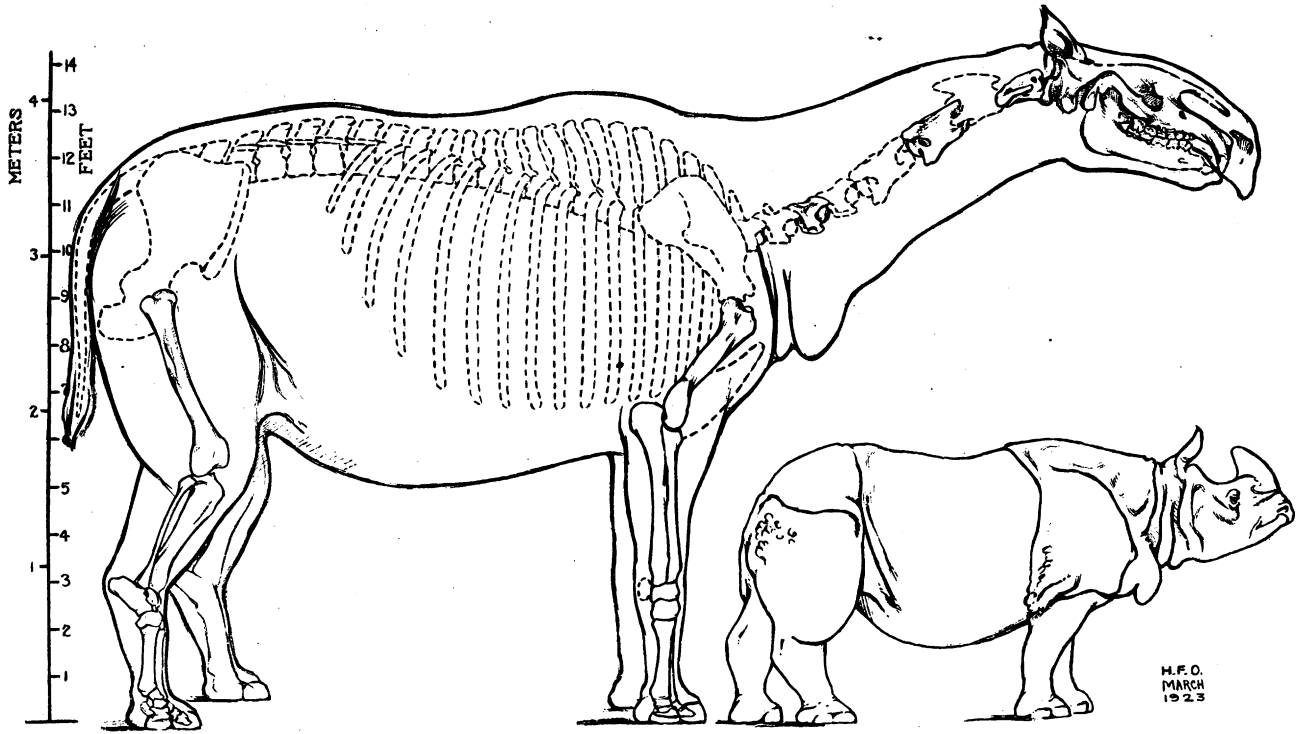

Fig. 9. Partial restoration of skeleton of *Baluchitherium grangeri* and *B. osborni* combined. Body contours, compared with those drawn to full size of the Indian rhinoceros (*R. unicornis*), drawn to the same scale.

specific forms known as *osborni*, *asiaticum*, and *grangeri* are closely similar in size, the differences indicated in the accompanying comparative measurements being partly attributable to age, or growth, and to sex, male or female. The proportions of the skull are fortunately exactly determinable from the superb American Museum type specimen No. 18650. The skull belongs to an animal larger even than the individual which possessed the gigantic neck vertebræ figured by Cooper; yet the skull, gigantic as it is, appears proportionately small. The length of the neck has been ascertained by a comparison of cervical 1 (atlas), cervical 3 and cervical 6, figured and measured by Cooper; the proportions of the neck and head are very similar to those in a giant specimen of the horse from Kansas preserved in the American Museum.

The height of the fore limb has been determined by the humerus, ulna, carpals and metapodials, figured and measured by Cooper, but it is apparent that this fore limb, like the neck, belongs to an individual inferior in size to the American Museum skull. The scapula is restored in dotted lines by careful comparison of the scapulæ of *C. simum*, *R. unicornis*, and especially of the American Oligocene aceratheres *A. occidentale* and *Cænopus tridactylus*. The *Baluchitherium* scapula will probably be found to have: (1) a large glenoid region for the massive head of the humerus; (2) a strong coracoid for attachment of the biceps; (3) a relatively high, narrow blade adapted to the elongate muscles of the elongate limbs; (4) inasmuch as the humerus is very distinctly rhinocerotoid in form (*fide* Cooper), the scapula must have the form of cursorial rhinoceroses; (5) the posterior border is more projecting than in *C. simum*.

The hind limb may be estimated from comparison of the measurements given by Cooper and Borissiak with the proportions of the limbs and calcaneum preserved in the American Museum collection. The pelvis is given a vertical rather than a horizontal character in adaptation to weight; the pelvis and the hind limbs, and especially the abbreviate proportions of the tibia as compared with the femur, correspond with the graviportal quadrupedal type of Osborn, the ratio between tibia and femur being: Tibia, $790 \times 100 \div$ femur, $1200 = 66$. The corresponding ratios in the following quadrupeds are:

	Tibia	Femur	Tibio-femoral Ratio
Indricotherium asiaticum Bor.	860 mm.	1230 mm.	70
Baluchitherium osborni F. C.	790	1200	66
White Rhinoceros (*C. simum*)	343	523	66
Indian Elephant (*E. indicus*)	618	1020	60
Loxodonta africana ("Jumbo")	755	1050	72

Consequently, we infer that the locomotion in the hind limb of *Baluchitherium* was of Osborn's graviportal type, namely, that of the rhinoceroses and elephants. The closest correspondence in the actual length of the femur is with *Loxodonta africana* (in the skeleton of "Jumbo") which measures 1050 mm.; the hind limb of *L. africana* is shorter as a whole than that of *Baluchitherium*, but the tibia is relatively longer in *Loxodonta*.

The radio-humeral ratios, that is, the proportion between length of radius and that of the humerus, are also on the whole rhinocerotine rather than elephantine. The corresponding ratios in the following quadrupeds are:

	RADIUS	HUMERUS	RADIO-HUMERAL RATIO
Indricotherium asiaticum	976 mm.	930 mm.	105
Indian Rhinoceros (*R. unicornis*)	385	385	100
White Rhinoceros (*C. simum*)	364	381	96
Indian Elephant (*E. indicus*)	685	810	85
African Elephant (*Loxodonta africana*)	870	1000	87

These measurements show that, while the actual combined length of the radius and humerus in *Indricotherium* equals 1906 mm. and that in *Loxodonta africana* equals 1870 mm., the radius is relatively longer in *Indricotherium* (ratio, 105) and resembles the ratio of *Rhinoceros unicornis* (100) more closely than the low radial ratios of the Indian elephant (85) and of the African elephant (87). The radio-humerus is as elevated in *Baluchitherium* as in the elephants, while the metapodials are much more elevated, which accounts for the greater height at the shoulder in *Baluchitherium*.

	METACARPO-HUMERAL RATIO	METATARSO-FEMORAL RATIO
Baluchitherium osborni	52	
Indricotherium asiaticum	59	41
Rhinoceros unicornis	48	36
Ceratotherium simum	45	31
Elephas indicus	22	13
Loxodonta africana	20	14

The above ratios show that the baluchithere podials (41) are relatively higher than in the two rhinoceroses (36 and 31); they are very much higher than in the two elephants (13 and 14). In other words, the metapodials are relatively three times as tall in the baluchitheres as they are in the elephants; this accounts for the much greater height of the baluchitheres at the shoulder and at the hip.

The astragalus and calcaneum exceed in size and in length those of the Pleistocene mammoths, e.g., *Elephas jeffersonii* type, Amer. Mus. 9950, but the structure of both the astragalus and calcaneum is distinctively rhinocerotoid (*teste* Forster Cooper, 1923).

RELATIVE BODY AND LIMB PROPORTIONS.—The height of the *B. grangeri* dorsal spines is nearer 13 feet than 12 feet, as originally estimated. The fore limbs, the trunk and the hind limbs are all within a square 4270 mm. long by 3965 mm. high; the height-length ratio is 92; as compared with a giant horse (*Equus caballus*) in which the same ratio is 94; or with the Indian rhinoceros (*R. unicornis*) in which the same ratio is 82; or with the extremely short-limbed teleocerine rhinoceros which falls within a square 1200 mm. high by 2060 mm. long, the same ratio being only 58.

CHARACTERS OF THE **Baluchitheriinæ**, NEW SUBFAMILY

There is no doubt that *Baluchitherium*, while most closely parallel to the Aceratheriinæ, belongs in an entirely distinct line of descent or phylum of its own, to which the name **Baluchitheriinæ** may be applied, or **Paraceratheriinæ** in case by any chance this animal proves to be synonymous with *Paraceratherium bugtiense*.

The polyphyletic evolution of the rhinoceroses was pointed out by Osborn in 1898 in his memoir on 'The Extinct Rhinoceroses,' Preface, p. 77; it was carried to a further point in 1900 in his 'Phylogeny of the Rhinoceroses of Europe,' in which the subfamilies (I.) Diceratheriinæ, (II.) Aceratheriinæ, (?II*a*.) Elasmotheriinæ, (III.) Brachypodinæ, (IV.) Ceratorhinæ, (V.) Atelodinæ, and (VI.) Rhinocerotinæ were clearly defined as indicating early separation, absolute distinctness, and great geologic age.

The new subfamily, Baluchitheriinæ, is most clearly distinguished as follows. (1) The caniniform adaptation of the second upper incisor tooth, which will probably be found to be correlated with a second lower incisor tooth quite dissimilar to that in any of the Aceratheriinæ; consequently both the upper and lower second incisors of the Baluchitheriinæ are distinctive. (2) The second feature of great importance is the horse-like elongation of the entire cervical region which is also a unique subfamily character. (3) The third feature, although not quite so distinctive, is the marked elongation and lateral compression into a functional-tridactyl-monodactyl type. (4) A subsidiary subfamily feature is the relatively small size of the head which with the greatly elongated neck we may correlate adaptively with tree-browsing habits, that is,

browsing on the higher branches and leaves of trees, as compared with the shrub-browsing of the *D. bicornis* of Africa or the *R. sondaicus* of India in which the head is carried very low and near to the ground. (5) An additional subfamily character is the peculiar proportions of the head, neck, fore limb, hind limb, and trunk, which, while more rhinocerotine than equine, are nevertheless unique among rhinoceroses.

HABITS OF BALUCHITHERES.—The writer anticipates that the baluchitheres will be found to be unique, large animals of the particular geologic period, either Upper Oligocene or Miocene, in which their remains occur; they were typical browsers and probably browsed on the herbage of the lofty branches of trees, as do the elephants and giraffes and to a less extent certain of the chalicotheres. They were amply defended by their powerful tusks. The type skull of *Baluchitherium grangeri* indicates that these animals attained a greater height, when the neck was elevated and stretched, than 14 feet, nearer 15 and possibly 16. The writer further anticipates that, when the complete fore limb and scapula of *B. grangeri* become known, it will be found that the shoulders were elevated above the hips, as in the chalicothere *Moropus*, in the okapi, and in the moose (*Alces*), because it is generally found that the anterior part of the body of tree-browsers is elevated in correlation with the elongation of the neck. It is obvious that tree-browsing animals of increasing height, of length of neck, of height of shoulder, and of stretch of prehensile lips would be constantly selected, as in the giraffes.

ABEL, OTHENIO. 1910. 'Kritische Untersuchungen über die paläogenen Rhinocerotiden Europas.' Abh. k. k. geol. Reichsanst., XX, Heft 3, pp. 1–52, Taf. I, II. Wien.

BORISSIAK, A. 1915. 'Sur le genre *Indricotherium* (*Indricotherium* n. gen.).' Geol. Vestn., No. 3, pp. 131–134, text figs. 1, 2.

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