New materials of the subfamily Indricotheriinae Boriss. (Baluchitheriinae Osb.)

by A. A. Borissiak*

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The last expedition of M. V. Bayarunas into the Turgai region, equipped by the Geological Museum of the Russian Academy of Sciences in 1916, has brought new materials of *Indricotherium*, the description of which could not get in full into the recently printed monograph on this form.*

Aside from that, in a short period over the course of the last year(1923), there appeared several works on the same group of fossils, explaining, the structure of the cranium, among other things, which is still lacking in its complete form in the collections of our Museum. With regard to the great interest represented by the new group of rhinoceroses, it is necessary to give even a short account of all the data.

The materials of *Indricotherium* produced by the mentioned expedition could not bring any essential additions to the already well-known picture of the structure of its

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skeleton (the cranium is also absent from the new materials), however they give some interesting details and partly complement some small gaps about individual bones.

The dental apparatus, aside from the magnificent upper jaws (molars), also has a full series of lower molars, previously unknown, an upper P^1, likewise unknown earlier, and several very large upper incisors (described in the mentioned monograph as tusks). But as before, there are not full series of either upper or lower teeth, on the basis of which one could judge the position the of incisors in the jaws of *Indricotherium*. However, other finds, and mainly the cranium of *Baluchitherium* described by Osborn (more about it later), oblige us to suppose that in the Turgai form, the front part of the cranium also presented high specialization and possessed only one pair of upper incisors, of the quality of a tusk (these, apparently, are those teeth described in the monograph as tusks), and a maximum of two pairs of incisors peculiarly set in the lower jaw [here probably belong the teeth described as incisors]. The teeth are described in this article with such an interpretation.

<u>The</u> <u>Upper</u> <u>Jaw</u>. <u>Incisors</u> <u>[tusks]</u>. – There are two pairs [figs. 1, 1 and 2] of incisors in the upper (?) jaw:

Dimensions

	1-1463	2-1463	3-1463	4-1463i
crown length	50	51	54	52 mm
width	35	36	34	32 mm
height	61	60	62	60 mm
root length	—	175	140	142 mm
cross-section	—	67 x 53	63 x 43	63 x 44 mm

The new material complements slightly, yet essentially, the description of the crown of these teeth in the monograph. The crown has the form of a dull, massive cone, slightly flattened on the sides; on it are noticeable, more or less distinctly, the front and the back keels, and the front one is conditioned by a plane parallel to it (a smooth area); the position of the keels is quite asymmetrical. The enamel is roughly striated, and it is smooth only on the upper part of the cone (from use). The base of the front keel, shifted from the medial plane toward the internal side of the tooth, bears a small swelling, representing a rudimentary (lingual?) cingulum; however, it is noticed only on the first pair (1, 3), while the second pair (3, 4) is just as in the description of teeth in the monograph, lacking this formation. However, this cingulum, as well as the rugosity of the enamel, undoubtedly connects these teeth (i.e., the incisors of the upper jaw?) with the incisors of the lower jaw described earlier.

The root is much thicker than in the teeth described earlier, and in 2-1463 also longer; at the same time, it is hollow in the last tooth: the lower end is supplied with a wide aperture, and the cavity reaches almost to the crown of the tooth.

<u>Molars</u>. – There are two paired rows (fig. 2, II and III): B 1463 and C 1463, belonging to an old individual (because the teeth show considerable wear), and A-1463 and D-1463 (incomplete row), from a considerably younger individual (the teeth are slightly worn off); together with the row of teeth described in the monograph, and which shows almost no signs of wear, they give a complete picture of the change in the masticatory surfaces of the crowns of the molars of *Indricotherium* through grinding. Besides these there are several separate teeth.

[p. 128. Illustration. – Fig. 1, 1. Tusk (incisor) (3-1463) view from the side; 2 - ditto (2-1463); 3 – P^1 – first upper premolar; view of the crown from the side of the masticatory surface.]

Dimensions

	separate teeth	A & D right	A & D left	B & C right	B & C left
P^1 length	35	–	–	–	–
width	28	–	–	–	–
height	38	–	–	–	–
	1401 C				
P^2 length	39	42	–	44	45 mm
width	50	56	–	53	59
height	35	31	–	29	30
P^3 length	–	55	58	56	56 mm
width	–	75	78	70	75
height	–	45	41	45	36
P^4 length	–	62	–	63	61 mm
width	–	84	–	81	82
height	–	50	–	33	35
	E 1463				
M^1 length	83	74	–	70	76 mm
width	84	85	–	83	80
height	58	37	–	23	28
	F 1463				
M^2 length	83	92	91	93	92 mm

width	85	97	97	92	91
height	58	53	55	45	43

G 1463

M^3 length	100	110	106	100	101 mm
width	95	95	93	87	87
height	45	60	60	51	53

First Premolar: – A single specimen (fig. 1, 3) of a tooth untouched by grinding: by the lack of wear, it corresponds to the series of teeth described in the monograph, but from the opposite (left) side.

The crown is of a form extended in length (the length is considerably greater than the width), and it narrows slightly anteriorly (an irregular trapezoid in outline).

The ectoloph forms the essential part of the crown, in the form of a massive wall, the upper end of which presents an angle (almost a right angle), and is asymmetrical (descending more sharply toward the anterior end). The external side of the wall is nearly smooth. Only a very small parastyle is modeled at the base of the wall, and a larger fold at the near end, possibly corresponding to the tritocone; thus the protocone takes chief participation in the structure of the ectoloph, forming the entire medial part of the wall. On its internal side, both cones are better fashioned, and the posterior (tritocone) is slightly bent inward relative to the anterior (protocone).

Of the transverse ridges, the anterior is distinctly developed, representing a low ridge to which a strongly swollen cone is attached at its posterior (internal) end, although not higher than the ridge. This cone can be considered a deuterocone, but more correctly (see later) it could be taken for a tetartocone. The near ridge is represented by a small thorn (tritoconule), whose position is the same as in other premolars; i.e., the internal end is directed toward the anterior end of the mentioned cone, and in agreement with the position of the latter is somewhat bent anteriorly (however less than in P^2).

The cingulum is small, mainly on the anterior and posterior sides. The root is absent.

[Fig. 2. I. *Baluchitherium grangeri* Osb. (according to the plaster cast). II. (B 1463), III. (C1463), and IV. *Indricotherium asiaticum* Boriss. Tr. = tetartocone; d = deuterocone; E = external fold of lower premolars.*]

Thus the character of this tooth somewhat violates the regular sequence of change in the characteristics of the crown in premolars; namely, the tritoconule is less turned anteriorly at its internal end than in P^2 (one would expect the opposite), and the tetartocone is better united with the deuterocone (likewise).

<u>Second</u> <u>Premolar:</u> – All three teeth (A, B, C) are considerably abraded and represent sufficiently differentiated masticatory surfaces of the crowns. However, a closer study of these crowns leaves no doubts as to the full identity of their structures with the completely unabraded tooth described in the monograph. No new details in the structure of this tooth are apparent; the only thing that can be stated regarding teeth B and C is a somewhat triangular, rather irregular trapezoidal (quadrangular), general outline of the

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* The plaster cast of the cranium of Baluchitheria was obtained by the Museum after this article had been sent to press, and therefore there is no characteristic of its teeth in this text. As distinctions from the teeth of *Indricotherium* appear: a better-developed tetartocone on all premolars (therefore the tritoconule is turned more forward at its lower end) and better isolated, transverse ridges on P^2. The series of upper molars of *I. asiaticum* described in the monograph (*Reports of the Ac. of Sci.*, XXXV, no. 6) takes the middle place according to the development of tetartocone, between I and II. Compare also the description of premolars above, p. 130. All drawings (by photo) on the same scale.

crown. The unusual width of the external wall is well demonstrated [visible on the tooth described earlier] by the relative weakness of the transverse ridges. The near ridge appears especially underdeveloped, which at a certain degree of abrasion represents a round patch of tetartocone, adhering to the external wall by a thin (narrow) neck, the tertoconule; later (A, C) the external wall enters into direct contact with the tetartocone by a wide protuberance, preserving its regular round outline and right union with deuterocone; both transverse ridges of the crown present a continuous and consequently a covered crochet (not worked out transverse ridges).

As always, the form and development of the cingulum presents some differences among the three teeth. Likewise, the position of the plane of abrasion is different, and correspondingly the highest point (top) on the external wall is now close to the anterior end (in the region of the protocone) (in B and C), now it is in the middle (between the proto- and tritocones).

The roots have been preserved to the best degree in one tooth (B). There is a large root in the form of a wide [the entire width of the crown] lamina, bending at an angle and downward from the internal end. The lamina consists of two or three cones uniting together downward from the posterior wall (corresponding to trito- and tetartocones) and two downward from the internal (corresponding to tetarto- and deuterocones). The second root is of much smaller dimensions and is situated below the internal wall on its external half; it represents a thin lamina of two cones. The length of the large root (the preserved part) is 60 mm.; of the small one, 40 mm.

The second premolar ($\frac{1401}{C}$), incompletely preserved (partly broken), stands aloof, differing from the others also by its (much smaller) dimensions. Its crown is abraded to a considerable degree; but its structure is nevertheless distinctly observed. Its chief peculiarity consists of the fact that the deuterocone is fully separated from the tetartocone, and in such a manner (on the abraded crown) that both transverse ridges appear quite worked out. In other characteristics this tooth is quite similar to others.

Attention must be drawn to the fact that in his *Baluchitherium grangeri* Osborn depicts the crown of this tooth thusly.

<u>Third</u> <u>Premolar</u>: – As in P^2, all four teeth (A, B, C, D) have abraded crowns, at the same time to varying degrees; therefore, the posterior transverse ridge now appears in the form of a separate islet (A, D). Now it unites with the external wall and with the tetartocone to form a narrow neck.

There are no other distinctions in the structure of the crown from the earlier described specimen, with the exception of the mentioned posterior ridge. The tritoconule forming it in the P^3 described in the monograph is besides turned anteriorly at its internal end; the posterior transverse ridge has the same direction in the strongly abraded jaw (B, C), while in the less abraded one (A, D), the islet of the tritoconule is turned anteriorly and back, it is true, barely noticeable.[(1)]

In the less-abraded teeth (A, D), the modeling of the external wall is clearly visible on two cones (later in B, C they unite into one wide ectoloph), and likewise on the deutero- and tetartocones of the anterior transverse ridge: closely united, they form a very thin anterior ridge bending downward from the internal wall. As mentioned, the posterior ridge represents either a thin cross-piece or a separate islet. In such form, the crown of this tooth of *Indricotherium* very much recalls some Oligocene American forms.

As for the root, it is constructed on the same type as in P^2, only that it is correspondingly larger. The length of the large root (down the posterior and internal ends) is about 70 mm, the same as in the small one (down the external half of the anterior end). Sometimes the first root is divided in two (B).

Fourth Premolar: – The character of abrasion is as in the preceding teeth, and peculiarities of the structure of the crown are likewise exposed. Separate teeth represent individual peculiarities relating mainly to the degree of development of the tetartocone: it is developed least in P^4 (A) and best in P^4 (B, C), however always less than in P^3, in agreement with the general tendency of the dental series of *Indricotherium*.

We may say besides that in P^4 (B, C) the internal and the external walls are not as much mutually inclined as in other P^4.

The roots of this tooth show a tendency to divide the wide platform of the posterior side in two parts, of which the smaller, external part forms an independent cone, and the internal fuses with the root of the internal wall.

The Molars of both new jaws (A, D and B, C) permit us to remark only on the following peculiarities. For the first molar, there are no new data. In the second molar, in both new jaws, the antecrochet is no less developed than in the M^1 described in the monograph. Whether the M^1 antecrochet was also more strongly developed in them than in the one described earlier is impossible to say, because of very strong abrasion. Regarding M^3, it can be said that in the second jaw (B, C) the pin (calk) is absent on the external side of the posterior ridge; but instead in the corresponding place on that ridge there is an external wrinkle along its entire height to an even greater degree than the pin, testifying to the primitive features of this tooth (a curved posterior ridge); its antecrochet is variously developed in A, D less than in B, C.

Besides the molars belonging to the more or less complete jaws, there are three separate teeth that present the following peculiarities:

M^1 (E 1463) should be related to M^1 and not to M^2, although its general dimensions more recall the outlines of M^2; but the character of the external wall, which does not form an inward curve, and some other features, such as the relatively longer posterior ridge, oblige us to regard it as an M^1, but from a very large specimen. In contrast, an M^2 (F 1463) with exactly the same dimensions shows all the features of M^2. M^3 (G 1521) does not present any peculiarities.

The description of the teeth of the upper jaw does not bring much novelty compared with the facts we know about the earlier ones. However, the new material calls for the following remarks:

First of all, the teeth described earlier presented almost a total absence of abrasions, and as such their various elements were strikingly distinctly expressed on the crown. The jaws now being described show a considerable and at the same time different degree of abrasion and, as always happens, the general aspect of the crown suffers correspondingly significant changes. Its thorough study leaves no doubt regarding the fact that the structure of these teeth is the same as in those described earlier – but for the above-mentioned small exceptions – but the worn ridges present the familiar picture much better, and this last obliges us to question whether we have a right to state categorically (see monograph, p. 17) that the structure of the premolars of *Indricotherium* has, according to its primitive character, an equivalent among other rhinoceroses. It is possible that the unabraded condition of the teeth of other Oligocene forms would also present a no less primitive picture.

Further study of the premolars speaks persistently in favor of the fact that of the two possible interpretations of the structure of the crown of premolars (see monograph, p. 20), preference should be given to the second; i.e., that the tetartocone should be recognized as most distinctly developed in the front premolar;* correspondingly, this tooth appears molarized to the greatest degree, because the anterior and posterior transverse ridges are better separated, thanks to a better-separated tetartocone. However, in contradiction to this, the triangular form of the tooth and the uniting ridges (tritoconule turned anteriorly at its internal end) remain just the same. On the abraded teeth, where the transverse ridges appear more worked out, this last feature is less conspicuous. Such interpretation results essentially in a reverse relationship of similarity and difference with other primitive forms, both American and European, than had been accepted earlier. Like *Epiaceratherium*, *Indricotherium* should be related to the American type of primitive rhinoceroses (monograph, p. 18).

<u>The Lower Jaw</u>. <u>Molars</u>: – The new material has for the first time produced a full series of molar teeth from both sides of the lower jaw (fig. 2, IV).*

Dimensions	Right side	Left side
P^2 length	38 mm	39 mm

* The position of the tretoconule, which always joins the front part of the same cone (tetartocone) with its internal end, calls for this interpretation.

* Apparently, the excavators found the whole lower jaw; but before it could be subjected to the necessary working over (due to its great friability) and corking (packing), a passing cloudburst destroyed it; only the teeth and small fragments of bones were preserved.

width	26	28
height	34	40
length of root	36	53
P^3 length	52 mm	51 mm
width	39	37
height	37	35
length of root	55	--
P^4 length	61	59
width	44	44
height	45	41
length of root	80	–
M^1 length	66	–
width	53	–
height	29	–
length of root	–	–
M^2 length	86	85
width	60	58
height	36	30
length of root	85	97
M^3 length	92	92
width	60	62
height	48	44
length of root	122	–

First Premolar: – Apparently lacking (P_2 does not show traces of its attachment).

Second Premolar: – Has a crown of oval outline, consisting of a massive central (medial) cone and two conelets anteriorly and posteriorly. The central thorn and the anterior correspond to the anterior semilunarity with an unusually powerfully developed posterior ridge (protoconid and metaconid), especially at its posterior part (Me^9), which fills the entire middle of the crown in the form of the mentioned massive, round, three-branched cone (the two-branch angle is turned anteriorly; posteriorly, the third branch of the cone). Anteriorly, the parastylid adjoins it in the form of a small crochet (hook), and posteriorly, the posterior semilunarity joins in the form of a slightly larger crochet; i.e. probably the hypoconid. The posterior semilunarity joins almost toward the middle of the last branch of the medial cone (a little closer to the external side), and the external end of this branch forms a sharp, although small, ledge directed posteroexternally on the external side of the crown (figs. 2, 3).

The crown is abraded to a small degree only on its top ridge, which hardly disturbs the original (up to abrasions) interrelations of the parts. The cingulum is developed powerfully enough, especially on the external side, surrounding the tooth on all sides. The root is double, with two lobes, anterior and posterior, and each of them has two fused cones.

<u>Third Premolar</u>: – The crown is round, rectangular in outline, extended in length, slightly narrowing anteriorly. It is constructed on the same type as the preceding tooth, but more closely approaches the normal molar: the anterior and posterior semilunarities are quite distinctly traced; but as before, the posterior ridge of the anterior semilunarity still predominates, occupying half the crown. Its anterior ridge is small and much shorter; the semilunarity is curved twice into the form of the letter Π, but the anterior is slightly anteriorly directed. The posterior ridge is relatively better developed than in the second premolar, namely, while its external part is bent into a right angle, the internal one is short and abruptly narrowing. Likewise, the part extending onto the external side of the anterior semilunarity forms a deep ledge, directed posteroexternally and slightly

separated by a small vertical furrow from the remaining surface of the external side of the anterior semilunarity. The external (posterior) end of the ledge forms a jagged ridge.

The cingulum is likewise powerfully developed.

The root is as in the preceding tooth.

Fourth Premolar: – The crown has a nearly regular, elongated, quadrangular outline; it narrows only slightly toward the anterior end.

The anterior semilunarity is worked out to a much greater degree than in the preceding tooth, representing a ridge bent twice into a right angle, and its posterior part (posterior ridge) is developed incomparably more strongly than the anterior one (anterior ridge), and its internal end (metaconid) spreads, forming an internal wall on the tooth, as it were, as in preceding teeth. The anterior ridge of the anterior semilunarity (parastylid) is much shorter; it narrows abruptly and terminates in a sharp keel. On the external side, the posterior end of the external part of the anterior semilunarity forms a posteriorly extended ledge, as in the preceding teeth; but is still more distinctly separated from the remaining surface of the tooth by a jagged (warty) external keel.

The posterior semilunarity is considerably smaller than the anterior, bent into a right angle, whereas its posterior ridge ends without reaching the internal end of the tooth, where an isolated tubercle (entoconid) fills the posterior valley. The cingulum is developed as in the preceding tooth. The root likewise has two lobes, anterior and posterior, each formed of two fused cones.

Molars: – Characterized by an anterior semilunarity twice-bent into an angle with a very poorly developed anterior ridge (thin, in the form of a sharp rib), whereas in M_3 the angles of the curve are almost straight, and further anteriorly they grow ever sharper (correspondingly duller). The posterior semilunarity is relatively larger in M_1, and further posteriorly it grows smaller and less curved (relative to the anterior one); correspondingly, the posterior half of the tooth is more powerfully developed and wider in M_1, whereas it is the anterior one in M_3.

Other features of molars have been characterized sufficiently in the monograph in isolated teeth, whereas in comparison with data on the entire series of teeth, one can say of the teeth described earlier that 7^{1401} and 8^{1453} represent M_2, and 9^{1401}, M_1; the latter has an unusually great length. The roots are in the form of two massive lobes, anterior and posterior, each made of a pair of massive cones.

Similarities and Differences

The teeth described are characterized by a very primitive general habitus, which is expressed in the underdevelopment of ridges, with a very powerful modeling of separate cones on the internal ends of the ridges (this less-expressed feature has considerable diffusion besides), with a greater distinction of premolars from molars (by a slight molarization of the first). This last forms the most original sign of the described jaw; *Eggysodon* (see *Eggysodon gaudryi*, Roman, *Arch. M. Lyon*, 11, pl. VI, fig. 2) is perhaps closer to it than others, according to the type of premolars (not molars) in which the posterior ridge of the anterior semilunarity likewise appears as the dominant part of the crown of the premolars. The internal end of this ridge also spreads in this form, forming a kind of internal wall on the tooth. Next mention should be made of the very simplified (shortened) P_2, and of callous ridges on the posteroexternal angle of the anterior semilunarity of all premolars (fig. 2, r), a feature apparently not noted in any of the known forms.

Of the bones of the skeleton, the remains of vertebrae are of greatest interest (unfortunately not very numerous), and among them a nearly complete cervical vertebra, which makes possible a comparison with the same bone of *Baluchitherium*. Besides this vertebra, there is a fragment of an atlas and a very much damaged dorsal vertebra.

$\underline{Z^{1463}}$ Atlas: – There is a fragment of the first cervical vertebra, of which the ventral side is preserved, the anterior articular ends, and part of the posterior ones; the alae are not preserved.

Dimensions

length along lower side	110 mm
width of both front articular planes	260 mm

The ventral side is flat, slightly saddle-shaped, with a slightly raised, round medial (longitudinal) keel, from which proceed depressions on both sides along the middle of the lateral parts of the ventral surface. The anterior articular surfaces are rounded-triangular in outline, regularly but not very deeply depressed. They do not approach the fragment of the cranium, whose protuberances are greatly separated due to deformation. Traces of foramina are preserved on the side of the dorsal surface.

Similarities and Differences

One can remark that this atlas is very close to the atlas of Baluchitheria, according to the dimensions of the parts preserved.*

Cervical Vertebra: – Nearly complete (fig. 3), probably sixth cervical vertebra (it cannot be the seventh, because it has arterial channels). Its articular surfaces are greatly

* Forster-Cooper, *Baluchitherium osborni*, *Phil. Trans. R. S. London* (13) 212, p. 35.

corroded; it is possible that the epiphyses are lacking (not grown with the centrum); i.e. we have the vertebra of a young specimen.[*]

Dimensions

posterior articular surface (without epiphyses)	225 x 145 mm
width with alae (ends broken)	420 mm
length of the centrum (without epiphyses)	200 mm
length along the upper surface	160 mm
length along the lower surface	150 mm
anterior articular surface (without epiphyses)	175 x 120 mm

The centrum of the vertebra is flat, the articular surfaces are oval in outline, extended transversely, and slightly inclined toward the axis of the centrum. The dorsal surface of the centrum is flat with a weak keel centrally, and with small depressions on the sides of the keel, arranged in pairs. The ventral surface bears two very deep depressions in the anterior part that shape the high cutting keel. Posteriorly, these depressions become shallower, and the keel is expressed more weakly. However, it extends to the posterior end of the vertebra (a distribution from 34[1442]). The anterior articular surface (corroded, without epiphysis?) has a rectangular-round outline and a very convex (evenly convex) surface; insofar as can be judged by the corroded surface, its dorsal end is almost straight, and ventral, probably slightly convex. The posterior articular surface is larger than the anterior, more strongly extended in width, and has an almost straight ventral end, whereas the dorsal is convex.

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[*] The vertebra (341442) described in the monograph distinguished by a more elongated centrum (and by many other peculiarities) evidently belongs to a more frontal part of the neck (fifth?).

The neural arch is preserved almost completely, not considering the corroded articular surfaces. The neural foramen is almost round, slightly flattened from dorsoventrally (88 x 74 mm), and considerably expanded posteriorly (at the same height). The spinous process is lacking, and the nearly flat dorsal surface of the neural arch is slightly bent anteriorly with two large, callous, thicker parts on the sides of the posterior edge (above the postzygapophyses), from which two small keels proceed toward the central point of the anterior end. Likewise, the prezygapophyses are arranged on an elevation and protrude considerably anteriorly. They are apparently slightly inclined anterodorsally inside and have a convex surface (anteroposterior axis); their general outline is round-triangular, with the top placed anteriorly. The postzygapophyses protrude much more slightly posteriorly, directed posteriorly, externally, bent ventrally, and likewise have a round-triangular form.

The transverse processes are open, because they are pierced by an extensive arterial cavity that extends deeply into the central part of the vertebral centrum, narrowing it to a thin lobe. The openings of these cavities are unusually large anteriorly, larger than the neural foramen, somewhat smaller posteriorly. The alae of the transverse processes are broken.

<u>Similarities</u> <u>and</u> <u>Differences</u>

In comparison with vertebra I, vertebra B[*] is considerably more flattened dorsoventrally. The centrum of vertebra I is higher, the neural canal is not flat; but high. The openings for the arterial cavities are set differently (higher set, larger in dimensions). As for the dimensions, they are very similar with exception of the length of the vertebra

[*] Forster-Cooper, *l.c.*, p. 38.

(200 in I; 300 in B), which is smaller in *Indricotherium*; indeed, vertebra I lacks epiphyses, and possibly with epiphyses, after further growth, the vertebra would reach the dimensions of vertebra B in length, but then the other dimensions would correspondingly increase. In short, we cannot speak about the identity of vertebrae I and B.

<u>1463?</u> <u>Thoracic</u> <u>Vertebra</u>. – Apparently fully similar to the one described in the monograph (38^{1442}), or very much like it.

Dimensions

length of centrum	100 mm
front articular surface	140? x 150? mm
width with diapophyses	340 mm
length of awned growth (from cerebral canal)	500 mm

The centrum is very short (both articular surfaces are preserved). The articular surfaces are set obliquely. The other features are quite the same as in the one described earlier (38^{1442}), which is in general better preserved. On this specimen can be noticed the five-angled, rather curved form of the posterior articular surface, and the long spinous process, which is almost completely preserved; it has a three-branched form with a deep, semi-cylindrical groove along the posterior side. The thin ends of these grooves are largely broken. Its dorsal end is not fully preserved.

<u>Similarities</u> <u>and</u> <u>Differences</u>

In comparison with vertebra B^1, occupying approximately the same position, vertebra I is distinguished by its smaller dimensions, relatively smaller width of the spinous process, and a different form of the anterior articular surface, which is much higher; especially distinct is the structure of the spinous process, which in B is flattened anteroposteriorly and very thin (therefore Forster-Cooper considers it to be very short), showing in such a manner considerably greater specialization – if all these particular features are not the result of deformation in the stock.

Of the other bones, the following merit attention:

1463 Scapula: – There is a much-corroded and quite incomplete bone (it is preserved to the same degree as that pictured in fig. 2 of the monograph), besides the second of the earlier-described bones is somewhat better restituted by separate fragments.

Dimensions (1463)

greatest length of the articular surface	180 mm
greatest width of the lower end,	260 mm

88^{1250}: – Only the second of the bones mentioned is of interest, because it testifies to a rapid and significant expansion of the body of the bone after a small narrowing above the lower articular surface (see the description in the monograph, p. 57). The body of the bone is on the internal side slightly convex (not bent) (I c. p. 57); near the anterior end of this side, its surface represents a small, elongated depression. Correspondingly, the external side is bent in, but its anterior end is slightly bent inward, so that it is downward and convex. Thus in cross-section, the body of the blade has an extended S-shaped section. The front anterior is still thinner (cutting) than the posterior.

The spine is restored only partly on the lower end and on the upper. It is slightly bent, not anteriorly, but posteriorly. It begins down very near the articular surface and rapidly enlarges in height. However, its entire rib is broken (it is not preserved). Toward the dorsal end, it descends very gradually and at the same time expands (i.e. here the body of the bone becomes thicker). The general length of the preserved fragment (the dorsal end is lacking) is about 700 mm.

Similarities and Differences

The rapid expansion of the bone-body corresponds partly to that theoretical construction of blade B, which is given by Osborn (*l.c.*, p. 10).

Radius: – A whole bone, but considerably deformed.

Dimensions

general length	1060 mm
greatest thickness of lower end	210 mm

The bone is nearly straight, flattened slightly anteroposteriorly, with a flat posterior side and a convex anterior. In length the bone is bent posteriorly, anteriorly it is straight. Thus its shaft is thinner in the central part than on the ends, which are very thick. The thinnest part lies in the upper third of the shaft, and the upper end is less swollen than the lower. A more detailed description of the bone shaft cannot be given because of its considerable deformation. The description of the articular surfaces of both ends of the bone has been given earlier.

The bone being described appears as the pair of the earlier-described ulna (monograph, 65). The deformation of both bones hinders us in portraying their mutual relations; but we can state that the ulna closely touches the proximal end of the radius from the posterior side, and then as it passes to the external side of the radius, it forms with the latter a small gap.

Os pisiforme: – The sole specimen is a left bone. According to the dimensions of the articular surfaces, it belongs to a smaller individual than the earlier-described carpus (monograph, vol. VII, fig. 5).

Dimensions

general length	148 mm
height of rear end	98 mm
front articular surface	56 x 50 mm

The bone is flat, expanding slightly toward the posterior end, which ends in a crescent-shaped, callous thickening. Likewise, the anterior end bears a small callosity externally (in the upper end), and on the inside it is considerably extended, forming the articular butt of the bone. This latter consists of two blades lying almost in one plane, and in cross-section they form a horizontal, slightly S-like curved rib; the lower articular surface for the os cuneiform has an irregularly crescent-shaped outline (the external side is very much expanded, bearing a triangular hollow) with a slightly bent surface. The upper fore-ulna has a more triangular outline, extended upward, and a cylindrically concave, inward-curved (bone from right to left) surface.

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Turning now to the new literature on Indricotheriinae, it must be pointed out that M. B. Pavlov's article on the remains of *Indricotherium transouralicum* appeared later than the works of Forster-Cooper, Osborn, and others mentioned earlier.[*] Let us see all these works in order of their appearance.

[*] See – Reconstruction of Indricotheria, *R. R. A. S.*, 1923, p. 111.

Forster-Cooper's article[*] contains description of the remains of Baluchitheria that he found in Baluchistan in 1911, a preliminary report of which had been made already in 1913;[*] on the basis of the latter in the monograph[*] on Indricotheria, a comparison was given of the bones mentioned in this report with the Turgai form. In Forster-Cooper's article that has now appeared, we are acquainted with all the material obtained in Baluchistan. In comparison with the Turgai material, it is not large, and does not by far contain all elements of the skeleton;[*] besides, as in the Turgai find, these remains point to the presence of individuals of different size.

With the monograph mentioned earlier appeared the preliminary description of the osteology of *Indricotherium*[*], and this work showed great influence on Forster-Cooper's article: admitting the great similarity, perhaps even identity, of his form with the Turgai one, he characterized the missing parts of the skeleton of *Baluchitherium* according to the data of the mentioned work,[*] thereby artificially enlarging the impression of identity of both forms. He even correspondingly introduced some changes into the characterization of the bones of *Baluchitherium*.

In the meantime, if the question of the relationship of both forms is as yet insoluble (see further), then profiting by the descriptions present, it is possible to suppose

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[*] *Baluchitherium osborni* (? syn. *Indricotherium turgaicium* A. A. Borissiak), *Philos. Trans. R. Soc. London*, (13) 212, p. 35-56, February, 1923.

[*] *Ann. a. Mag*., 1913, p. 376, p. 504.

[*] *Notes of the Academy of Science* (VIII) XXXV, no. 6, 1923.

[*] *Reports of the Academy of Science*, 1917, 287.

[*] This led astray even a few researchers reporting on the find in Baluchistan, which was supplemented by the Turgai materials, while actually the Turgai materials are much more complete. See Abel, *Die Naturwissenschaften*, 1923, Heft 15, S. 884.

[*] Here is the list of these bones: 4 vertebrae, 2 scapulae, fragment of ulna, femur, tibia, patella, all bones of the carpus, a few in several specimens, 3 astragali, a navicular, 3 podials and phalanges.

considerable differences between them. Regarding the vertebral characteristics mentioned above [pp. 139-141], it can be said that the vertebrae of *Indricotherium* are in general shorter than the vertebrae of *Baluchitherium* and less flattened dorsoventrally. From the description and depiction of other bones, the following peculiarities of both forms can be pointed out.

<u>Humerus</u>: – Under the same discussions of the articular surfaces, humerus B is considerably shorter than humerus I (840 versus 930 mm), besides the poor preservation of the proximal end in I, there are nevertheless traces of the sulcus bicipitalis, which in B is not in the best preservation, but the general form of the articular surface is the same. The structure of the distal end is in general similar, but in B the lower articular surface has the typical rhinoceros habitus in the form of two cones ("hourglass – sandglass"), fusing with the tops, whereas in I it represents two concentric cones, and therefore forms a sharp intercondylar keel, abruptly descending to the intercondylar furrow; in B the intercondylar furrow is even flatter than in rhinoceroses.

<u>Ulna</u>: – There is only the upper end; judging by the drawing, similarity with the bone of I is very great, but if the drawing is made exactly at 1/8, then the dimensions are considerably smaller, and a different interrelationship of the dimensions of the individual parts results (for instance, fossa semilunaris and olecranon).

<u>Femur</u>: – If the drawing is correct, it is apparently a flatter bone than in I, and expands less toward the proximal end: but is greater "on the extension of the shaft", in I it is more bent sideways. On the distal end the condyles are much more directed downward than in I and are much more asymmetrical (in I cond. medialis and cond. lateralis are almost level, and in B the first is much larger than the second). Also the femur of B has

an insignificant third trochanter, as that of I; this last was denied in the preliminary description, consequently one of the essential distinctions of I from B mentioned at that time was the presence of the third trochanter in the former.

Patella: – Distinguished by the form of its articular surface.

Tibia: – Shorter than in I, and it expands considerably more downward.[•]

Carpus: – All bones in B are of slightly smaller dimension than in I; distinction of the articular surfaces can be observed (the upper articular surface on the lunate, and the same on the cuneiform); the height is greater than the length on the trapezoid of B, in I inversely; the magnum in B is less flattened, there are marks in upper articular surfaces, and the platform for Mc II lies on the lower side, whereas in I it belongs just as much to the lateral; in particular, the large mark of the upper unciform articular surface. If we take the carpus as a whole, it is relatively higher than in I.

Tarsus: – Astragalus and navicular show less significant distinctions (in the arrangement of the posterior articular surfaces of the astragali, etc.), ectocuneiform (judging by the drawing, the author apparently imagined it in reverse).

Metapodials: – The specimen depicted is the bone of the central toe, apparently from the hind limb, and has a shaft of more regular form with less swollen ends; the length of this bone altogether is 370 mm (in I, 520). The bone from the lateral toe is flat in the lateral direction, as in I; but the outline is different. Judging by these bones, the pes of B must be shorter than that of I.

The phalanges also present distinctions.

[•] Fig. 1213 of Forster-Cooper portrays (apparently) the proximal and not the distal end.

As for the restoration of the pes of B, apparently the factual material in it was represented only by tarsal bones and partly by phalanges, while the metapodials represent the interpretation by the author of the Turgai material.

With reference to the structure of the pes, as well as other bones, the author makes expansive copies from the work of the Turgai form; among other things, he argues with the explanation of features of monodactyly, considering that this pes shows not morphological but functional monodactyly.

Interesting is the general conclusion of the author, who does not think it possible to establish the taxonomic position of his form among the Perissodactyla. In his characterization of individual bones, he resorts to comparison with various groups, as was done earlier in the work regarding the Turgai form: with ungulates, and among other things, he likewise finds not a few horse characters in skeleton B, but he did not have its dental apparatus; more correctly, he related those crania and lower jaws that he found together with the bones of B to another genus, *Paraceratherium* (an animal smaller in dimensions), and supposed that the teeth described from the Turgai location, although larger than his *Paraceratherium*, were still very similar and therefore must belong to a different form than the skeleton.[*]

In March, 1923 this monograph of *Indricotherium* appeared several times,[*] and in May, the work of Osborn that described the skeleton and a few bones of the gigantic rhinoceros from the Miocene deposits of Mongolia.[*]

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[*] In a small article, placed later in *Nature*, no. 2809, 1923, p. 327, 1 September, he already admits the membership of B to the rhinoceroses; but still considers that its "position is not clear". In this article, an important statement is that the cranium of *Paraceratherium* differs by its structure from the cranium of B, described by Osborn.

[*] A. Borissiak, On the genus *Indricotherium*, n. gen. *R. A. S.* 18, XXXV, no. 6.

This latter material was obtained by the Third Asiatic Expedition of the American Museum of Natural History in two places, in central (Loh) and southeast (Iren Dabasu) Mongolia, in the upper part of the Gobi Desert, related by the geologists of the expedition to the Miocene.[*]

Besides the cranium and incomplete lower jaw, carpal and tarsal bones and the distal end of the humerus were found here.

As the conclusion of his article partly shows, Osborn, contrary to F.-Cooper, takes the same point of view as the author of the Turgai form; i.e., he unites the skeleton with the dental apparatus and admits that it belongs to the new group of the gigantic Mammalia of the family Rhinocerotidae, within which it should be ascribed to a particular subfamily (Baluchitheriinae), as had been done earlier by the author of the Turgai form (Indricotheriinae), the monograph on which had not yet been received by Osborn when he printed his work. As for the interrelationships of all the known forms of the new group, Osborn rightly does not identify them even in relation to genus until sufficiently convincing material is collected; but he foresees the possibility that they all will prove to be synonyms of *Paraceratherium*, the first-described form with regard to small individuals.[*]

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[*] H. F. Osborn, *Baluchitherium grangeri*, a giant hornless rhinoceros from Mongolia. *Am. Mus. Novitates*, no. 78.

[*] See Berkey, Ch. and Granger, W., *Amer. Mus. Novitates*, no. 77, 1923, 23 May; see also Anderson, Essays on the Cenozoic of N. China. *Mem. Geol. S. China* (A), no. 3, 1923.

[*] The above-quoted remark of F. Cooper apparently excludes this supposition.

The greatest significance of Osborn's work is the description of the cranium; thanks to this description, we are for the first time acquainted with the cranium* of one of the representatives of the new group.

Apparently the dental apparatus of this cranium, inasmuch as is possible to judge from the small drawing, and the characteristic shortness, is very close to *Indricotherium*.

Thus, the protoloph, large rear internal tetartocones, and a rudimentary metaloph are visible in P^2. In P^3, the protoloph is in the form of a long hook-like ridge, fusing with the tetartocone; P^4 is still larger with a very much projecting protoloph in the form of a hook, passing into the internal tetartocones, and within it is the narrow metaloph. P^4 is apparently wider than in *Indricotherium*. The general characteristic is an unusual backwardness in the development of transverse ridges of premolars.

The primitiveness of the molar teeth urged us essentially to also suppose a primitive character for the anterior part of the dental series (see monograph), of which there were as yet only broken sets of teeth, taken at first for incisors and tusks (on the analogy with *Epiaceratherium* and other primitive forms). The cranium described by Osborn leaves no doubt as to the high specialization of the anterior part of the dental series (see above, p. 128). There can be almost no doubt (after the work of M. V. Pavlova, see further) that the cranium of *Indricotherium* was also constructed on this type; but it would be as yet premature to speak of their full identity.

It is also very interesting that, in contrast to other rhinoceroses, the Indricotheriinae have a small head; the described cranium with enormous occipital condyles has disproportionately small dimensions of the remaining bones. Therefore

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* In Forster-Cooper's arrangement, there are several crania of *Paraceratherium,* however they have not yet been described.

claims that the upper teeth described in the monograph belong to a smaller Turgai form (*I. minus*) apparently must fall off. The latter must have had a still smaller dental apparatus.

From other elements of the skeleton found in Mongolia, judging by the data mentioned in Osborn's article, with reference to the calcaneum, it can be said (by the drawing) that its general outlines differ from that of *Indricotherium* (the body of the bone is on the top less girded, the appearance from the side is also different).

Osborn also mentions pictures of plaster casts of some bones of *Baluchitherium osborni* from Baluchistan. These pictures prove once more how much the lateral metapodial differs from the corresponding bone of *Indricotherium* (see above); the same for astragali, apparently the block is more flattened. However, the posterior wall is likewise at a right angle with the lower.

In this article of Osborn, there is their reconstruction* of *Baluchitherium*; but about this there was already a special mention.*

Later than the rest appeared the work of M. V. Pavlova,* which is of great interest because for the first time the lower jaw of a representative of Indricotheriinae was pictured with the anterior end preserved (however, without the teeth). This form, described as a new species, actually differs somewhat from the unworn dental apparatus

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* The second-reconstruction was based on the Turgai and Baluchistan materials of the skeleton. The first reconstruction was made on one cranium, while the skeleton was given a completely rhinoceros habitus as mentioned in the journal *Asia*, September, 1922. This reconstruction, together with the second, is very instructive for explaining the characteristic marks of the representatives of the new group, so much unlike the normal rhinoceros.

* *R. R. A. S.*, 1923, p. 111.

* *Indricotherium transouralicum, Bull. S. N. M. V. S.*, XXXI, 1922, 1923.

of *I. asiaticum*[*] pictured the monograph, also by its smaller dimensions and other features mentioned in M. V. Pavlova's work, although it must be admitted that the upper teeth of *I. asiaticum* in an abraded condition (see above) show a very close resemblance to M. V. Pavlova's form; this refers still better to the molars of the lower jaw.

As has already been mentioned, the anterior end of the lower jaw is of greatest interest. Up to the present, of all the known representatives of Indricotheriinae, the lower jaw has been described only in *Paraceratherium* – a relatively small form whose membership in this group had been established by the testimony of Forster-Cooper[*] regarding the remarkable similarity of its upper teeth with *I. asiaticum.*

This jaw (of all the material present in the hands of F.-Cooper, it alone is pictured)[*] is very much abraded. It is characterized by the unusually set incisors, only one pair of which are present, directed anteriorly.[*]

The great abrasion of the molars in this jaw hinders us making any kind of comparison. Osborn, who, together with the cranium *B. grangeri*, of which there is a fragment of the posterior part of its lower jaw, established the latter on the type of *Paraceratherium* following the first hypothesis of Forster-Cooper. The find, described by M. V. Pavlova, appears as the first, although incomplete, confirmation of such a supposition, like *Paraceratherium bugtiense*, the specimen of the lower jaw described by her has anteriorly directed incisors – more correctly, their alveoli, as the incisors have not

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[*] This species was established in 1916, see *C. R. V.* 162, nos. 4, 3 ave. 1916, p. 520.

[*] *l.c*., p. 63.

[*] *Ann. A. Mag., N. H*., 1911, (8), VIII, p. 710.

[*] The drawing testifies distinctly that there is only one pair of incisors, and there are no traces (alveoli) that would point to the possibility of finding a second pair; but the jaw is very old, and the alveoli of the small, fallen-out incisors could be hidden. This must be mentioned in further comparison.

been preserved. There is almost no doubt that they are the teeth described in the monograph under the name of incisors, which resemble so much the corresponding teeth of *Paraceratherium*. But after this come distinctions: in the specimen described by Pavlova, there is not one, but two pairs of alveoli for the incisors, and the upper one is considerably smaller than the lower,[*] so that it is possible to conclude that the second pair of incisors had been somewhat reduced. On the other hand, the incisors described in the monograph represent two types,[*] differing in the arrangement of the crown on the root and in the structure of the crown itself, while the dimensions of the crown are approximately the same; if these differences are not individual deviations (which is quite probable), it is possible to suppose that these incisors belonged to a form that had two pairs of equally developed incisors.

These data suggest some peculiarities between the Turgai remains and *Paraceratherium*, apparently in agreement with Cooper's[*] new point of view.

This article speaks for itself, and in conclusion little remains to be said. The material on the remarkable new group of rhinoceroses is ever increasing. According to the conditions of discovery in various regions and often of various parts of the skeleton, not always sufficiently accurately described in preliminary reports – the material collected has been referred to three genera (*Paraceratherium, Baluchitherium*, and

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[*] The jaw is somewhat deformed, which explains why the left empty alveolus is smaller than the right, in which the root has been preserved. It is possible that the upper alveolus was actually larger than the opening preserved.

[*] *Rep. of the Ac. of Sci*. (8), XXXV, nos. 6 and 7, vol. I, pp. 2-3.

[*] *Nature*, no. 2809, p. 327.

Indricotherium) and several species.[*] Their mutual relationships (this question was put earlier) cannot be accurately settled as yet even after all the new works. For this one must wait for new finds, mainly crania and lower jaws; but also other parts of the skeleton.

A correct determination of the age of the finds is likewise of great importance. According to the attendant forms, The Turgai find belonged to the upper Oligocene[*], and there are no new data that would compel a change in this determination. The Mongolian find is from the Miocene. Perhaps the difference in size will give an explanation of the essential difference of these forms and will shed at least some light upon the origin of this branch, which so early attained among the rhinoceroses its high and peculiar specialization, and which therefore also preserved so many primitive structural marks.

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[*] Thus, when the Turgai material was found, there was already a short description of the Baluchistan find, on the basis of which it was impossible not to conclude that the Turgai I according to some symptoms differed essentially from the B, representing a smaller degree of a peculiar differentiation, wherefore it was given a new generic name. Later, in a more detailed description it was shown that some distinguishing symptoms were absent [P. G. was shown the third trochanter on the femur in B that had been lacking in the preliminary description]; but other symptoms of distinction (see above) became known.

[*] Or the middle, according to Osborn