XIII. *The Extinct Rhinoceroses of Baluchistan.*

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Contents.

Introduction.

The occurrence of extinct forms of rhinoceroses in the Lower Miocene deposits of Dera Bugti in Baluchistan has been known for a long time. As far back as 1881 Lydekker described species from rather fragmentary material and later, in 1912, PILGRIM added very considerably to our knowledge of the fauna from the results of his own expedition to the locality.

The present account deals with specimens collected by myself during two expeditions to Dera Bugti in the years 1910 and 1911. The material available for description is unfortunately for the most part very fragmentary. In only one instance was a moderately complete skull found in association with its lower jaws. Specimens were obtained at various points round the Zen Koh range and were usually picked up as fragments washed out into the nullahs and therefore are of uncertain zone. At Kumbhi there were traces of a bone bed, but with its specimens much broken up. At Churlando, on the opposite side of the range, a better bone bed occurs, though even here there was very little association of the remains.

To understand the true generic position of a rhinoceros very complete material is necessary, as much as, and perhaps more than, for any other animal. The correlation, for instance, of skull, teeth, and feet is often of importance, and even with this knowledge the relationships of several genera are still hard to decipher; so that, with the present material, which often consists of only a few teeth, or at best a portion of a skull, the generic, or even the specific, position of the animal must remain in doubt.

In spite of this deficiency of material, the collection gives evidence of a large number and variety of contemporary rhinoceroses and, it is hoped, will make some addition to our knowledge of the group.

Since the collection was made much valuable work on the rhinoceroses has appeared. The investigations of American authors on the wonderfully complete material so often available in the deposits of the United States has resulted in an increased understanding of the rhinoceroses as a whole. The discovery, by RINGSTROM (1924), of the Pliocene fauna of China, and the work of the American Museum in Mongolia are of importance with reference to the Bugti fauna, and help towards a solution of the perplexing evolution of the European and Asiatic rhinoceroses. The confusion which obtains in this section is noticed later in the text, and is an inevitable result of dealing with incomplete material. Moreover, in order to illustrate the variety of the fauna, several specimens are here described and illustrated, but not named as new to avoid adding to an already overburdened synonomy.

ON GENERIC CHARACTERS OF RHINOCEROSES WITH REFERENCE TO THE SPECIMENS FROM BALUCHISTAN.

In discussing genera it is clearly desirable to have some standard agreement as to what are to be considered the more important characters to be used as guides; it is here, however, that a lack of agreement is most pronounced. For argument a recent classification by MATTHEW (1932) may be cited, it is as follows. Excluding the clearly defined side lines, the Hyracodonts, Hyrachyids, and Amynodonts, the true rhinoceroses are supposed to start from somewhere near the Oligocene genus *Trigonias*. From this starting point arose, as side lines, the hornless Baluchitheres with aberrant tusks, and the Diceratheres with normal tusks but with a pair of laterally placed horns. The remainder of the Oligocene rhinoceroses of the holarctic region are understood to be a collection of various genera termed "the *Cœnopus* group." From this group all subsequent rhinoceroses have evolved along separate lines.

The main characters on which these lines are founded are :—

(1) the presence or absence of upper and lower tusks ;
(2) the position and number of horns when present, or their absence ;
(3) the hypsodonty or brachydonty of the teeth.*

MATTHEW's diagram is here reproduced, fig. 1, to show his views on the general relationships, and it will be noticed, among other points, that of those genera considered in this paper *Chilotherium* is placed as a derivative of the *Aphelops* line, that *Brachypotherium* is regarded as ancestral to *Teleoceras*, and that "*Rhinoceros*" *blandfordi* is placed as a true *Rhinoceros, sensu stricto.*

This point of view is not that of all authors, a number of whom place all these forms as genera of a sub-family, the *Teleocerinæ,* and this divergence of view brings to a head the question of what constitutes a genus. The final answer to this question is still a long way off, and, before describing the specimens in the collection and discussing to what genera they are to be referred, it is necessary to examine the characters given to the various genera concerned.

For greater ease of comparison a number of generic characters, classified according to the views of various authors, have been drawn up in tabular form.

From this table it can be seen how difficult it is to know what selection to make of these scattered characters for guidance. Thus, if we follow MATTHEW in dividing *Chilotherium* from *Teleoceras* and in placing it near *Aphelops,* we must lay the greater stress on the absence of horns, and of the upper incisors, and on the difference in foot structure rather than on the several points of resemblance in other directions, such as the structure of the molars, and in characters on which other investigators have relied. It is clear from the list that, of the characters mentioned, there is an amount of combination in different groupings which makes any clear differentiation of genera very difficult. The well-constricted protocone of the upper molars, for instance, is a very noticeable feature, but is one equally characteristic of the genera *Aphelops, Peraceras, Chilotherium, Brachypotherium, Aceratherium,* and *Teleoceras.* It is so widespread a feature that it is of no value as a generic character, although often so used.

On the Presence or Absence of Horns.

Both OSBORN and MATTHEW have attached considerable importance to the horns in questions of phylogeny. If we can argue from what appears to have happened in another group of Perissodactyles, the Titanotheres, whose lines of evolution have been

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* MATTHEW does not seem to lay much stress on the relative length of the skull.

TABLE I.

	Cœnopus.	Aceratherium.	Brachypotherium.	Chilotherium.	Teleoceras.	Aphelops.	[= Dicerorhinus] Ceratorhinus.
Horns	Absent	Absent	Absent	Absent	Small nasal horn in male	Absent	Two horns.
Skull proportions	Dolichocephalic	Dolichocephalic	Brachycephalic	Brachycephalic	Mesaticephalic	Dolichocephalic	Dolichocephalic.
nasals	Straight and pointed	Pointed, rather long	Straight and pointed	Straight and pointed	Pointed, short	Abbreviated	Long, somewhat pointed, bent down at tips.
nasal notch	Over PM. 1	Far back, over PM. 4–M′	PM. 3–PM. 4	PM. 4	PM. 3	Over M′	—
crests	Double	Double	Single	Double and widely separated	Single	Double	—
occiput	Vertical	Vertical	Vertical	Vertical	Sub-vertical	Slopes forward	—
Dentition, formula	$\frac{2.0.4.3}{1.0.4.3}$	$\frac{1.0.4.3}{1.0.4.3}$	$\frac{1.0.4.3}{1.0.4.3}$ brachydont	$\frac{0.0.3.3}{1.0.3.3}$ hypsodont	$\frac{1.0.3.3}{1.0.3.3}$ hypsodont	$\frac{0.0.3.3}{1.0.3.3}$	—
tusks, upper	Well developed	Well developed	Well developed	Absent	Well developed	Absent (or vestigial)	Reduced or absent.
lower	Well developed	Well developed	Long, sub-parallel, pointing upwards	Long, everted, pointing upwards	—	—	—
molars	Simple	Strong ante-crochet, moderate crochet and crista, protocone moderately constricted	Protocone constricted, ante-crochet present	Protocone constricted, ante-crochet and crochet large	Protocone constricted, ante-crochet and crochet large	Ante-crochet and crochet well developed, protocone constricted	—
premolars	Primitive; molarization 2→3→4	Molarization 4→3→2; only moderately advanced	Rather primitive, parastyles well marked	Moderately primitive anterior pms. reduced, molarization 4→3→2	Anterior premolars reduced, anterior pm. much abbreviated, parastyles weak	Premolars not reduced	—
lower jaw	—	Angle well developed	—	Symphysis very broad	—	—	—
Feet	—	Persistently four-toed. Astragalus with two of the calcaneal facets fused	Short	Moderately short. Astragalus with three facets separated, not shortened	Short Astragalus much shortened	Moderately short Astragalus not shortened	Long. —
Period of genotype	Lower Oligocene, U.S.A.	Miocene, Europe	Upper Oligocene, Europe	Pliocene, China	Pliocene, U.S.A.	Pliocene, U.S.A.	Living, Asia.
Genotype	*C. mitis* (COPE)	*A. incisivum*	*B. aginense*	*C. habereri*	*T. fossiger*	*A. mutilus*	*C. sumatrensis.* Earliest described species *C. tagicus*, Upper Oligocene.

Certain genera have been described into which it is possible that some of the Bugti forms may eventually be fitted. Of these *Protaceratherium* (ABEL, 1910) is considered as an offshoot of the true *Aceratherium* line from which it seems to differ only in the less development of the crochet and crista and in the lesser stage to which the otherwise Aceratherine type of molarization has reached. *Epiaceratherium* (ABEL, 1910) and *Paracœnopus* (BREUNING, 1923) are genera of Cœnopine affinities. Of these, however, the first is a very primitive Oligocene type characterized by its upper tusks being canines and not incisors. It has been recorded by BORISSIAK (1921) from Turgai so that some similar stage is not impossible in the Bugti region. *Paracœnopus* has been erected into a genus for "*Aceratherium*" *Filholi*, "*Diceratherium*" *Shahbaz*, and, in error, for *Paraceratherium*. The characters of this genus are not very clearly defined nor are the species on which it is founded sufficiently known.

very carefully worked out (Osborn, 1929), we might expect lines of rhinoceroses to have evolved first as hornless forms and then, while some remained permanently hornless, others produced single, double or paired horns in various ways. It is hard to believe that any line or group could have started with horns and then have lost them entirely, or have changed their fashion from one to two horns, or vice versa, without some trace being left. The possibility, moreover, that separate lines may have produced similar types by parallelism cannot be ruled out.

Objection has been raised against a too great reliance being placed on horns as a criterion of affinity because in some species it is known that they were carried by the male alone, the female being hornless. This objection is perhaps not quite a valid one. A species in which the male alone is horn-bearing must be regarded in the argument as a horned one, as is seen in many of the Artiodactyla. The hornless female skull merely presents a practical difficulty in dealing with fossil specimens, as there may always be some doubt about the sex of a skull. There are other practical difficulties. In a fossil our only evidence of horns is based on the presence of an obvious swelling on the skull and on the rugosity of the bone. A skull of *R. simus*, in the University Museum of Zoology in Cambridge, shows hardly a trace of any swelling and an absolutely smooth surface under the well-developed second horn. Such a skull, if found fossil, would be considered as single-horned. The possibility therefore that some fossil skulls may be equally misleading has to be born in mind. Further, there are known several specimens of *R. bicornis* with three horns in line, *lusus naturæ*, which if they had been found as fossils would have been described as belonging to a new genus.

It seems demonstrable that laterally paired horns have arisen in well-separated lines. *Colonoceras*, for instance, *Metahyrachyus bicornutus* (Wood, 1929, p. 73), and the American Diceratheres are examples. It is possible, therefore, that some of the European and Asiatic forms, such as "*Diceratherium*" *minutum* (= *D. pleuroceros*, *croizeti*, *palæosinense*, etc.), some specimens of which abundantly named animal show paired lateral horns, may be an evolution separate from the American line, a view that is held in many quarters, and not true Diceratheres, a view which is equally strongly maintained in others. Far too often European and Asiatic specimens whose horn structure is entirely unknown have been placed in the genus *Diceratherium*. Presumably in such specimens the similar structure of the molar teeth has been relied upon, a very uncertain guide.

There is thus a very strong difference of opinion as to the use of the name *Diceratherium* for the European and Asiatic species. Wood (1929, pp. 72–74), quoting Troxell (1921, *a*, p. 41), states that "the name *Diceratherium* ceases to have its original sense, all inclusive, and is now limited to one phase of the horned rhinoceroses, the type of which is *D. armatum* Marsh. Other species of 'Diceratheres' may be, and some are, widely separated in their classification." This view is the one here adopted with regard to the Baluchistan species.

RINGSTROM (1924), on the contrary, uses the generic name for a number of European and Asiatic forms, as also have PILGRIM (1912), MATSUMOTO (1921), and others before. On the other hand, he restricts the otherwise widely used term *Aceratherium* to the one type species *A. incisivum* (KAUP, 1832).

While it seems clear that the information, in the present state of our knowledge, is not sufficient to decide these points, yet MATTHEW'S general thesis as to the value of horns is reasonable and tenable. Hornless forms can be kept separate from horned forms, even if this is in some species a sex-limited character. Likewise two horned forms are separable from the single.*

On the proportions of the Skull and Teeth in the Rhinoceroses.

The relative proportions of the skull and teeth are much used for the purpose of describing and separating genera of rhinoceroses, and such terms as "hypsodont" and "brachydont" (with their sub-divisions "sub-hypsodont" and "sub-brachydont") are in general use in describing the relative height of the teeth, as are the terms "dolichocephaly and brachycephaly" (with various further sub-divisions) in descriptions of the skull length.

While every author has, no doubt, a clear idea of his own interpretation of the meaning of these terms, there is so far no standard of agreement as to their use, and it is not always easy to correlate the description of one author with that of another. It is even possible to find that a tooth has been described by different writers as brachydont and also as hypsodont.

Proportions of the Teeth.

MATTHEW has used the relative height of the teeth and the progressive evolution of hypsodontism as important characters in the rhinoceroses, and quotes in his diagram, fig. 1, four stages : brachydont, sub-brachydont,† hypsodont, and sub-hypsodont.

There is no explanation, in the way of comparative measurement or otherwise, of what constitutes the difference, for example, between the terms sub-brachydont and sub-hypsodont beyond the fact that certain species are placed in one or other of the divisions.

To form some basis on which to work a certain number of forms are here illustrated, figs. 2, 3, 4. A satisfactory basis is not easy to determine, and, in the first place, it must be emphasized that only unworn, or at most very slightly worn, teeth are to be

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* Even if this is agreed, the difficulties are not quite surmounted regarding the relationships of some of the Asiatic species mentioned in this paper. MATTHEW, for instance, has recorded his opinion (1932, pp. 433–5) that *Chilotherium* has nothing to do with *Teleoceras*, but that it is connected with *Aphelops*. He states that *Aphelops* has a rudimentary horn. As *Chilotherium* is hornless there is here some inconsistency.

† It will be noticed that MATTHEW places the term sub-brachydont above brachydont. A more correct usage would reverse this order.

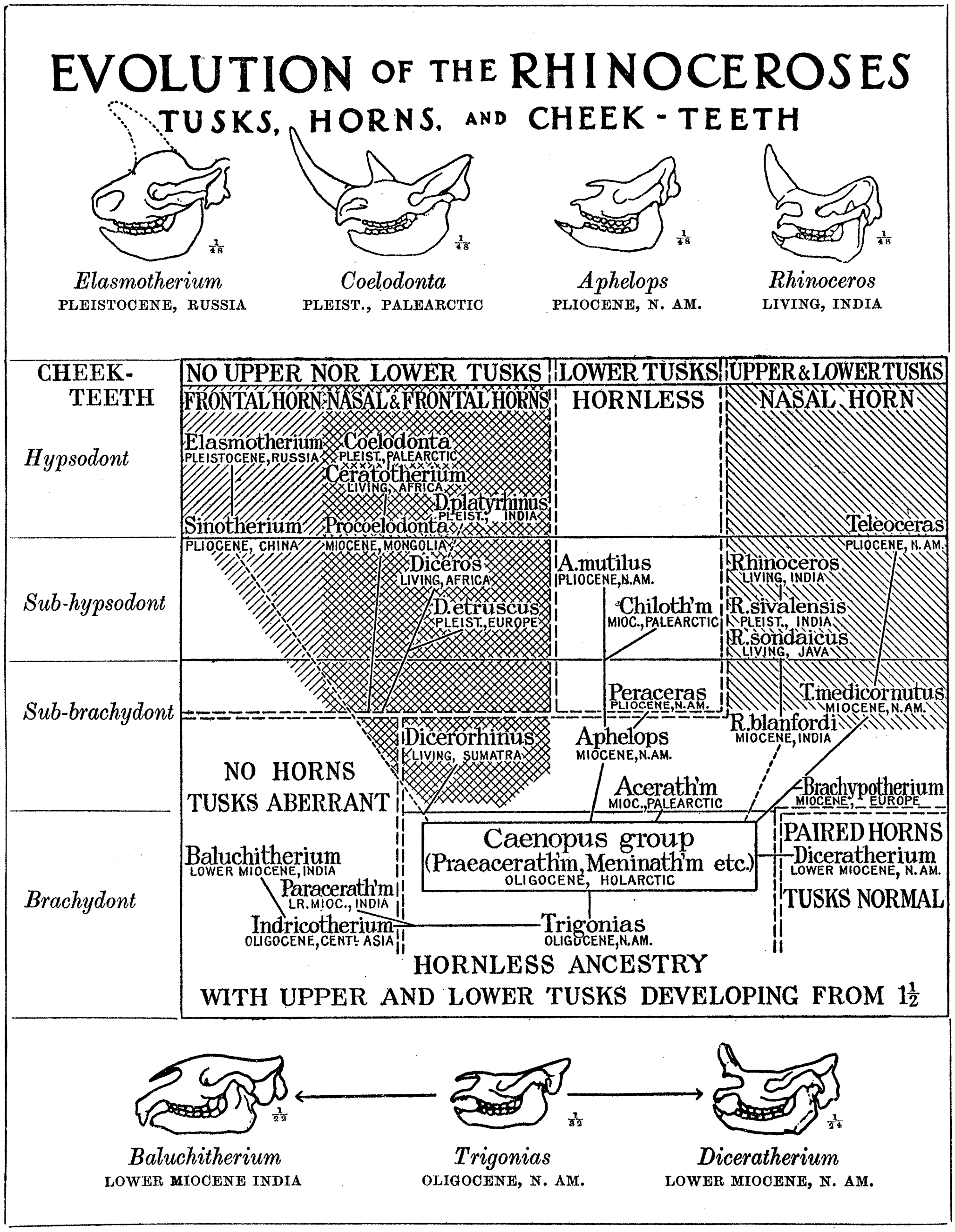

Chart showing evolution of the rhinoceroses. (After MATTHEW, 1931.)
Letters and method of shading have been slightly altered.
FIG. 1.

considered ;* preferably, it should be the same tooth in the series, since it appears that a molar and premolar may be somewhat different in their behaviour.

The basis on which the difference between a brachydont and a hypsodont tooth is founded usually appears to be the ratio of the length along the ectoloph to the height, as judged by the eye. This method can be curiously misleading because, when two

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* That this is necessary has also been pointed out by BORISSIAK (1927, *a*).

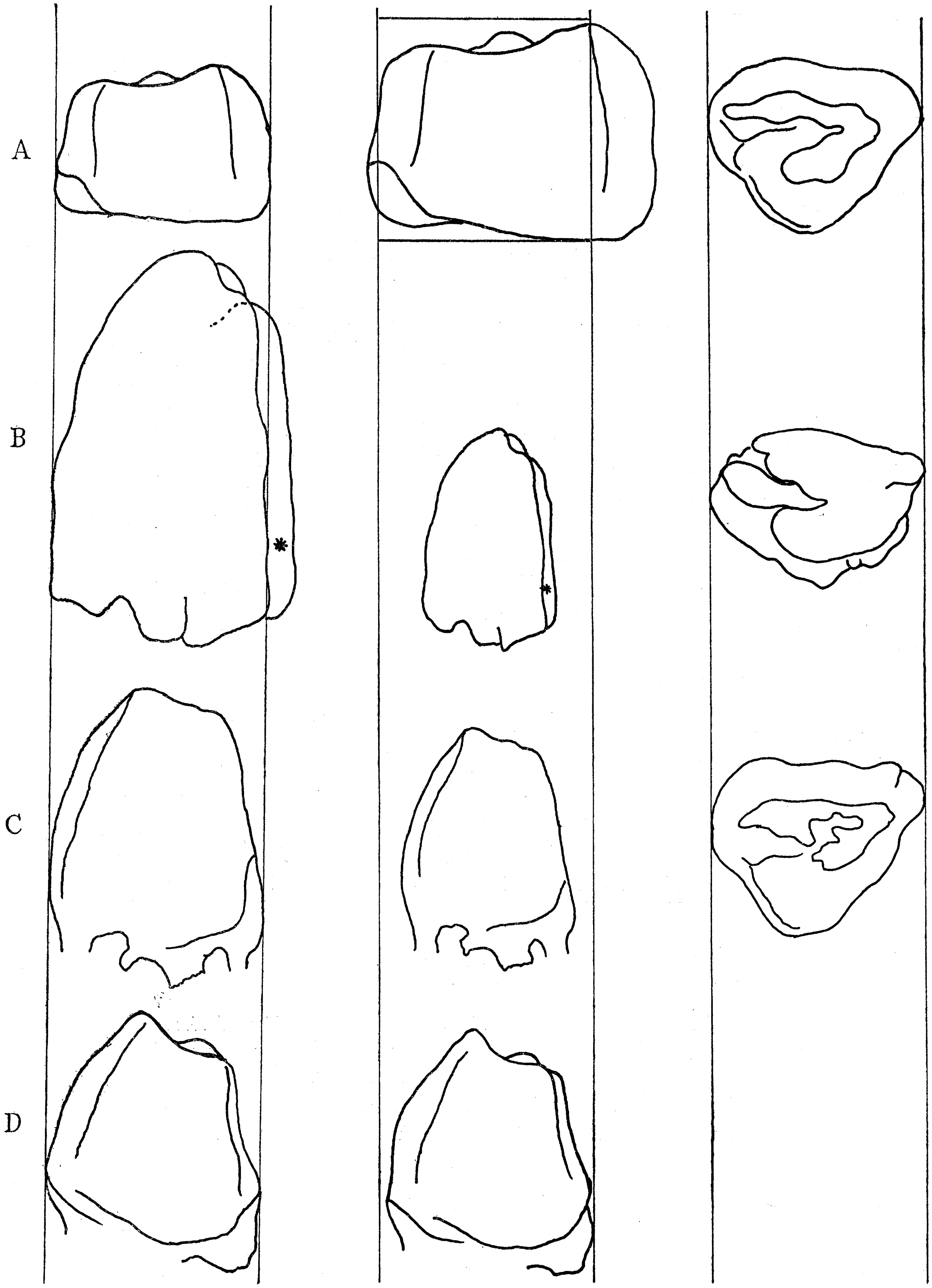

FIG. 2.—Outlines of third upper molars, reduced in the first column to a common width, in the second to a common height. In the third column the crown surface is reduced to a common width of the ectoloph. (A) *Paraceratherium bugtiense*; (B) *Rhinoceros sinus*. The * marks the metaloph which in this species projects in side view beyond the ectoloph; (C) *Rhinoceros bicornis*; (D) *Diceratherium* sp.

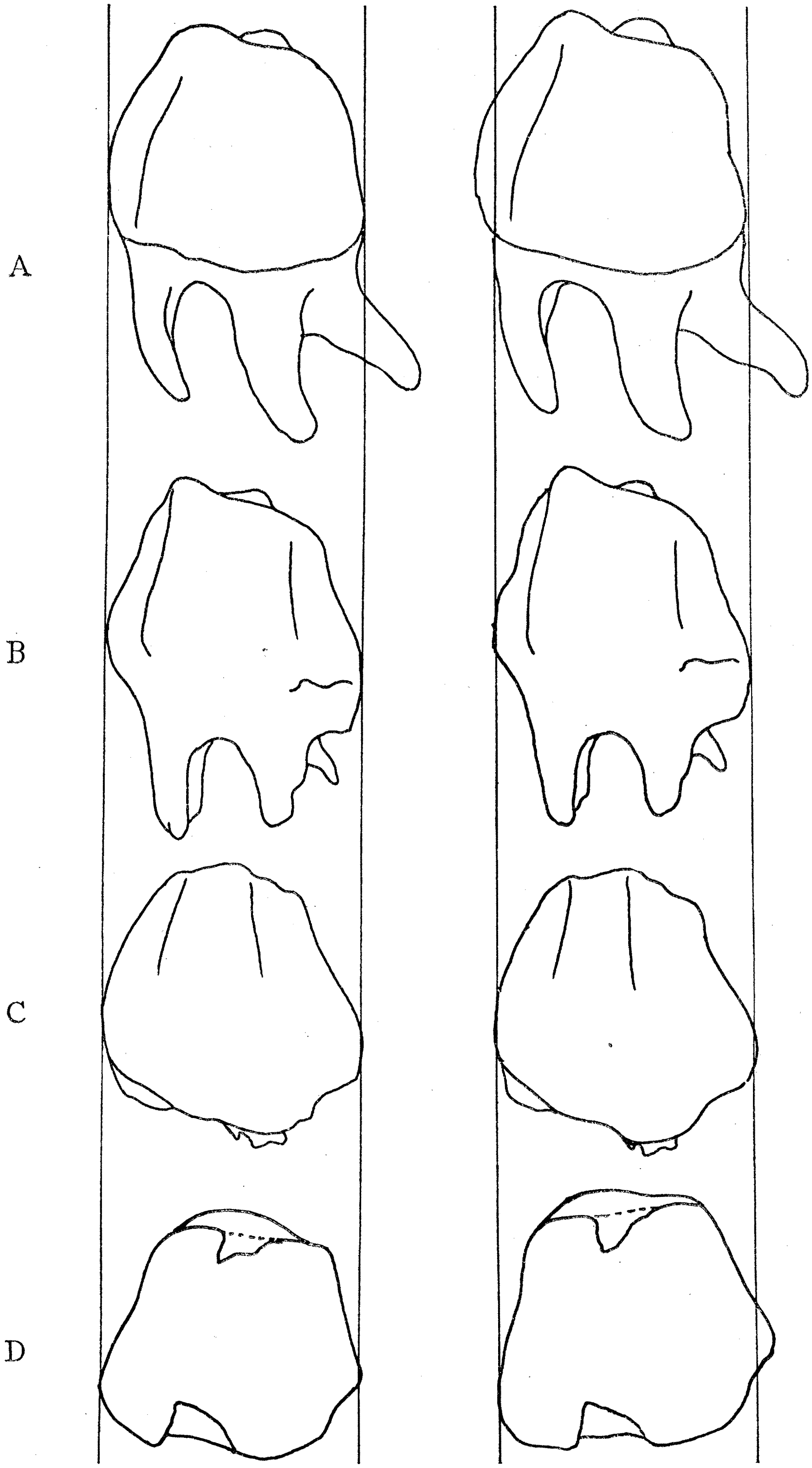

FIG. 3.—Outlines of third upper molars reduced as in fig. 2. (A) *Rhinoceros sumatrensis*; (B) *Rhinoceros sondaicus*; (C) *Rhinoceros leptorhinus*; (D) sp. *incertæ sedis* from Dera Bugti.

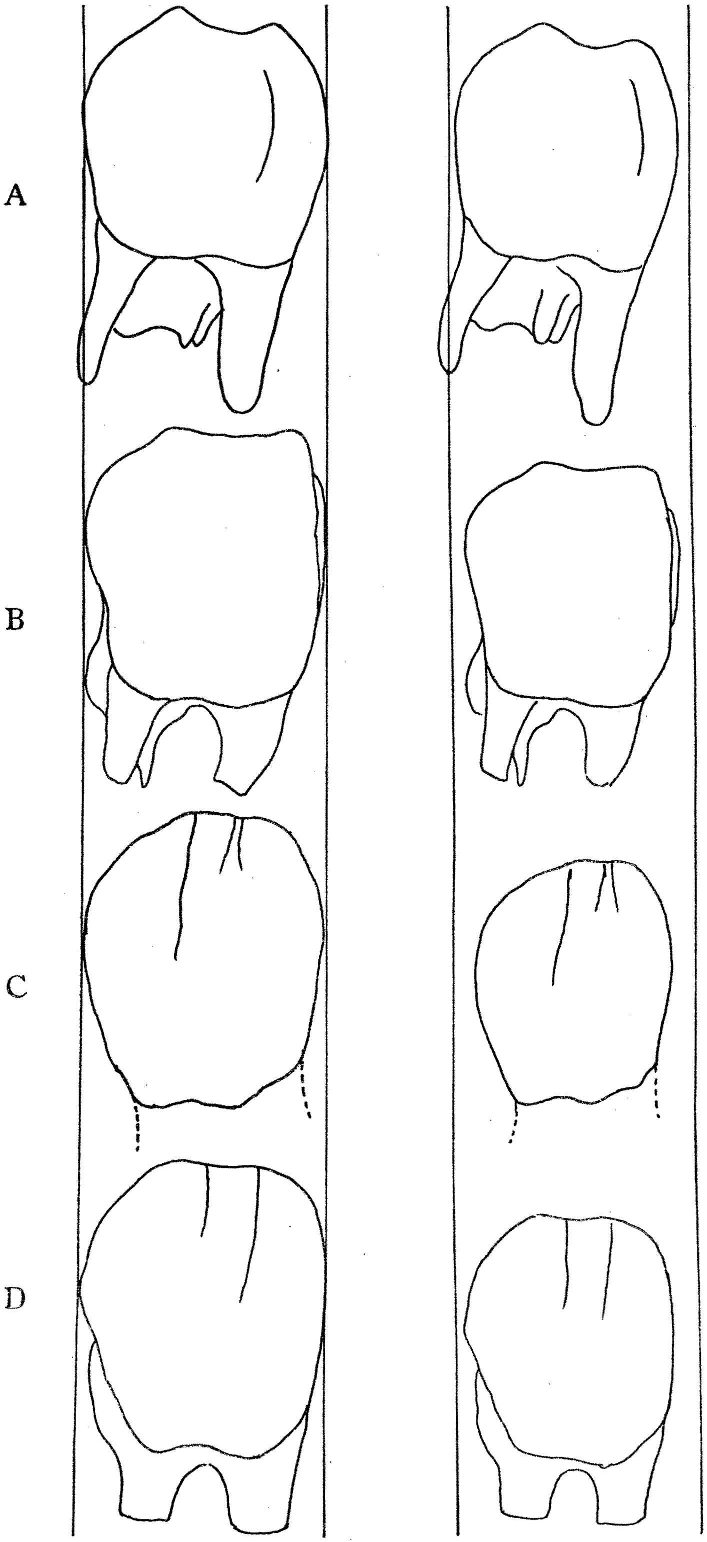

Fig. 4.—Outlines of first upper molars reduced as in figs. 2 and 3. (A) *Rhinoceros sumatrensis* ; (B) *Rhinoceros bicornis* ; (C) *Teleoceras fossiger* ; (D) *Rhinoceros unicornis.*

or more series of teeth are brought to a common standard, that of length, for example (which will then bring out the comparative difference in height, or conversely, if they are brought to a common standard of height, which will bring out the difference in length) the differences are often seen to be of very small amplitude. This can be demonstrated by comparing the figures of the third upper molar of *R. sondaicus*, fig. 3, B, *R. sumatrensis*, fig. 3, A, and a species of *Diceratherium*, fig. 2, D. Three forms which are termed sub-hypsodont, sub-brachydont, and brachydont respectively in MATTHEW'S diagram.

In figs. 2, 3, and 4 examples of teeth are shown to illustrate the method here adopted. The teeth are in the first place all reduced to a common length as measured along the ectoloph, and then to a common height, both being in side view. Finally, some are shown reduced to a common length in crown-surface view. Various resemblances and differences are thus brought out clearly to the eye, and for ordinary purposes this is probably sufficient. If it is thought desirable the differences can be expressed in figures, as shown in Table II.

In fig. 2 a selection of teeth has been reduced to the common standards as mentioned above. In the first column are shown the third upper molars, all unworn, of *Paraceratherium bugtiense*, *Rhinoceros simus*, *R. bicornis*, and a species of *Diceratherium* from America. *Paraceratherium* at the top of the column has been chosen as the most striking type available of a brachydont tooth, and this is followed by a tooth of *R. simus* as a type of the most hypsodont. All these teeth have been brought to a common width of the ectoloph.*

In the second column of the figure the same teeth are brought to a common height. For convenience this measure is the same as the width, so that the two combined form a square.

On comparing the first two figures in the two columns it will be noticed that the size of the teeth in column two is the reverse of that in column one. That is to say, a brachydont tooth increases in apparent area while a hypsodont one is diminished.† The tooth of *R. bicornis* is like that of *R. simus* in its general stage of hypsodonty, but to a less degree. The Dicerathere, on the other hand, shows very little change in area because the length and the height are much the same. In fig. 3 this series is continued with specimens of *R. sumatrensis*, *R. sondaicus*, *R. leptorhynchus* and an un-named specimen from Baluchistan. These teeth, with the exception of the last which is on the brachydont side, are all approximately alike in their proportions. In *R. sondaicus* the height of the tooth is almost exactly the same as the width, and a tooth of this proportion may be taken as a standard to which the term *mesodont* may very properly be applied. Compared with such a tooth, that of *R. sumatrensis* is on the brachydont

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* The tooth of *R. simus* is peculiar in that the ectoloph is so narrow that, in side view, a large part of the crochet can be seen. This is marked with a * in the figure. It is perhaps in part an expression of the extreme hypsodonty.

† These figures are only alternative ways of expressing the same fact.

side, but only to a very small degree, and certainly not enough to warrant the differentiation of the two forms into "sub-hypsodont" and "sub-brachydont" as is done by MATTHEW.

As far as the present investigation has gone, and here it must be admitted that the number of specimens and species examined has been much limited by circumstances, the majority of rhinoceroses appear to be mesodont as a general description, though differences of varying degree can always be expressed by reference to the standard of *R. sondaicus* or some similar type.

In the third column of fig. 2 the area of the tooth of three specimens, as seen in crown view, has been figured. Here the teeth have been brought to a common width as measured along the ectoloph. The differences between the teeth in this view seem less noticeable and it appears, at first sight at all events, that there is a more constant relationship of length to width than of length to height.* The range of variation between the extremes of hypsodonty and brachydonty, as shown by these figures, does not appear to be sufficiently great to give much assistance.

Fig. 4 shows a selection of first molars treated in the same way. It will be noticed that the tooth of *Teleoceras fossiger*, fig. 4, C, is strongly hypsodont, as are those of *R. bicornis*, fig. 4, B, and *R. unicornis*, fig. 4, D, though to a lesser degree.

In the figures given for *R. bicornis*, fig. 4, B, the proportion of hypsodonty is about the same in the first molar as it is in the third and, where comparison has been possible, this seems to be the general rule for rhinoceroses. In the two teeth of *R. sumatrensis*, fig. 4, A, however, the first molar appears slightly on the hypsodont side, while the third molar is slightly on the brachydont side of the same standard. The two teeth, being chosen for their unworn condition, necessarily come from different skulls, and it is possible that there is some individual variation within the species. As to the amplitude of this variation, nothing can be said until the opportunity arises of examining a more extended series of animals than has been possible at the present.

It appears therefore that, for the purposes of description, fine subdivisions with corresponding separate terms have not much to commend them, and that, without reference to some definite standard, they are without any useful meaning. The term *mesodont* for the standard, with the terms *brachydont* and *hypsodont* on each side of it, are sufficient, and with them any two or more species can be referred to the standard or to one another in a manner that will convey a definite meaning to another investigator.

Reference to the brachydont or hypsodont condition of a tooth implies the comparison of two measurements. The terms are, in fact, names for two groups of height and breadth ratios. As already stated, these measurements are usually made by eye and regardless of any help that may be obtained by the use of instruments of precision. If a numerical index be considered desirable it can be expressed as a ratio of height

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* Except in the premolars of some species, *e.g.*, *R. blandfordi*, which have the teeth of the anterior region much compressed from front to back.

and breadth and an advantage of this method is that it gives definite expression to a general impression obtained by the eye. When an attempt is made to deal with this problem in a more mathematical manner it is necessary to make clear which parts of the teeth are to be measured. Here the greatest breadth of the tooth has been taken regardless of the particular level at which it may occur. Similarly the height has been taken from the highest part of the crown to a point where the crown joins the roots and, as this point has to be estimated, an element of error may easily creep in. Accurate measurements, leading to a full description of the teeth, would go beyond the scope of the present enquiry and would probably cause the abandonment of the present descriptive terminology.

Using the method employed in the construction of figs. 2, 3, 4, we can obtain an approximate measurement for the height of a tooth from the level between the roots to the peak of the crown. The ratio of this measurement to the maximum breadth will define the proportions with moderate accuracy. It must be admitted, however, that the result is still only approximate, and care should be taken that the ratio is never made to express more than is justified by the measurements. It will be seen from Table II that, where the first and third molars have been measured, the ratios are close together, but that the teeth of such rhinoceroses as have been examined are separable into five groups. It would be interesting to see whether a more extended series of measurements would destroy or substantiate such a grouping.

TABLE II.

Species.	Tooth.	Height.	Breadth.	Ratio.	Ratio to one place.
R. sumatrensis	M. 1	7·1	7·15	0·99	1·0
R. bicornis, a little worn	M. 1	7·80	7·0	1·11	1·1
T. fossiger	M. 1	8·33	7·0	1·19	1·2
R. unicornis	M. 1	8·33	7·2	0·82	0·8
P. bugtiense	M. 3	4·93	7·05	0·70	0·7
R. simus	M. 3	11·22	7·10	1·58	1·6
R. bicornis	M. 3	8·38	7·05	1·19	1·2
Diceratherium sp.	M. 3	7·98	7·10	1·12	1·1
R. sumatrensis	M. 3	7·03	7·05	1·00	1·0
R. sondaicus	M. 3	7·12	7·00	1·02	1·0
R. leptorhinus	M. 3	7·40	7·20	1·03	1·0

From the above table the following five groups can be arranged :—

Brachydont less than 1.	Mesodont 1.	Hypsodont I 1·1.	II 1·2.	III 1·6.
Paraceratherium.	*R. sumatrensis.*	*R. bicornis.*	*T. fossiger.*	*R. simus.*
R. unicornis.	*R. sondaicus.*	*Diceratherium.*		
	R. leptorhinus.			

Skull.

We owe to Osborn (1900, 1902) a discussion of the dolichocephalic and brachycephalic conditions of mammal skulls in general and, so far as the rhinoceroses in particular are concerned, the statement that "a classification of the rhinoceroses based upon a consideration of the properties of the skull, correlated with the proportions of the limbs sets aside several homoplastic parallel characters heretofore employed in rhinoceros evolution and attempts to establish a firmer basis in the fundamental proportions of the skull, whether dolichocephalic or brachycephalic, in the correlated proportions of the body and in the location of the horn cores. These characters are found to be more distinctive of phyla than the pattern of the teeth."

An examination, however, into the "properties of the skull," *i.e.*, the cranial measurements, which themselves may be equally homoplastic in character, shows that the problem is far from simple. Any of the terms, such as dolicho- or brachycephalic, may cover not one type of skulls but several.

Osborn (1902) has pointed out that the terms come originally from human anatomy and refer, strictly speaking, to the cranial proportions in man. They have come into a general and rather vague use to differentiate any long mammal skull from a short one, regardless of the way the length or shortness may have been produced. As with the teeth this practice, without some standard of reference, seems to be unproductive of useful results.

In his great monograph on the Titanotheres (1929, vol. 2, p. 251), Osborn returns to the discussion of craniometry and gives what may be regarded as his considered opinion on the subject. For our immediate purpose it is only necessary to note the introduction of certain new terms and the further sub-division of some old ones.

Skulls in general are tabulated as follows* :—

- Dolichocephalic
    - Hyperdolichocephalic.
    - Dolichocephalic.
    - Sub-dolichocephalic.
- Mesaticephalic.
- Brachycephalic
    - Sub-brachycephalic.
    - Brachycephalic.
    - Hyperbrachycephalic.

These terms refer to the total skull length and others are proposed to distinguish elongation of the cranium from that of the face. Thus :

pro-opic dolichocephaly indicates an elongation of the face; brachyopy indicates a shortening of the face; opisthopic dolichocrany indicates an elongation of the cranium; brachycrany indicates a shortening of the cranium.

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* This table is with reference to the Titanotheres, but certain Rhinoceroses are quoted, *i.e.*, *R. simus*, as hyperdolichocephalic, *R. bicornis* and *R. sumatrensis* as dolichocephalic. Elsewhere Osborn mentions *R. sondaicus* as brachycephalic.

In his earlier paper OSBORN (1902) gives a list of skull and tooth characters correlated with the conditions of brachy- and dolichocephaly in general, many of which he states distinguish the rhinoceroses. Of living species he quotes *R. sondaicus* as the only living brachycephalic form, and *R. sumatrensis* as an example of a dolichocephalic type. The following list of characters is selected from his general list as being applicable to the rhinoceroses, and may be tested on the skulls of the two species.

		BRACHYCEPHALIC	DOLICHOCEPHALIC
1	Dental series	crowded	elongate.
2	Diastemata	closed	increased.
3	PM 1	suppressed	persistent.
4	Grinding teeth	shortened and widened	lengthened and narrowed.
5	Cingula between teeth	suppressed	persistent.
6	Whole skull	shortened and broadened	lengthened and narrowed.
7	Nasals	shortened and spreading	lengthened and narrowed.
8	Infraorbital foramen	not seen on side of face	well exposed.
9	Zygomata	broadened	elongate and vertically deepened.
4	Opposite dental series	convergent	more parallel.
11	Post-glenoid and post-tympanic processes	approximated below	open below.*

While the various indices given by OSBORN (1929) are undoubtedly valuable, it is not always possible to obtain them, as he himself points out, owing to distortion or incompleteness of the fossil specimens. A simpler method is here suggested, which is admittedly imperfect and empirical, but which enables us to use illustrations as well as actual specimens, and seems to bring out certain points of comparative measurement in a manner sufficiently clear to be of use.

For the purpose of comparison all skulls are to be brought to a common standard length, which is to be measured from the posterior edge of the occipital condyle to the front edge of the orbit.†

Skulls, in the course of their ontogeny, alter their proportions in all directions and there is no point which is absolute and stationary with respect to others, so that, as

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* This last character is not always strictly correlated with dolicho- or brachycephaly. *R. etruscus*, for instance, with a very long skull, has the processes as close together as any short-headed form.

† This may easily be done by taking photographs either of published figures or of actual specimens, then by making drawings of the required size on transparent paper, these can be superimposed and direct comparisons made. A machine with automatic focussing saves much time and trouble.

OSBORN (1929) uses the post-orbital process as a point of measurement. This area in the rhinoceroses is usually too ill-defined. Even the front of the orbit is not always easy to define, but an approximation may be made which will not seriously vitiate the result.

this differential growth makes any absolute standard impossible, some purely fiduciary one has to be made. For this the basi-occipital/orbital length has been chosen rather than any other, such as the facial length, or the length of the tooth series, because it comprises the more important brain region, which is perhaps less subject to variation than other parts, and partly because in fossil specimens this part of the skull is commonly better preserved than the more fragile facial portion.

In comparing any two skulls to find, for example, the slope of the occiput, they must have the same degree of orientation. To find a convenient formula for this is not easy. The ideal would no doubt be the line of the basicranium but, as this is not always available from figures or specimens, a line has been chosen joining the bases of the anterior premolar and the last molar. In comparing skulls these lines are brought parallel, so that the skulls are aligned approximately on the grinding surface of the tooth-series as a whole.

By superimposing outlines of skulls thus produced some or all of the following comparisons may be made, according to the state of preservation.

1. The elongation or otherwise of the facial region with reference to a common standard.
2. The shifting forwards or backwards of the tooth-series as a whole.
3. The position of the nasal notch with reference to the tooth series.
4. The relative slope and extent of the occiput.
5. The relative height of the cranium.
6. The relative length of the nasals and premaxillæ.
7. The proportional depth of the teeth.

Fig. 5, A and B, show the skulls of *R. sondaicus* and *R. sumatrensis* thus superposed. At first sight there does not appear to be much difference and, while most of OSBORN's points can be substantiated, it is arguable whether the two skulls can usefully be separated as dolicho- and brachycephalic. In side view, fig. 5, A, it can be seen that *R. sondaicus* has somewhat the shorter of the two skulls, but that it is also somewhat the lower and so, on the combined proportions of length and height, is not more brachycephalic than is *R. sumatrensis*. The occiput is more upright, and the nasal notch appears to be further recessed. The most noticeable difference appears in the relative position of the tooth-rows. These are actually of nearly the same length in the two skulls, but occupy a different relative position. In *R. sumatrensis* the " dolichocephalic " type the tooth-row has moved forward, so that PM. 3 coincides with PM. 1 of *R. sondaicus* the " brachycephalic " type. The nasal notch appears as more recessed in the first form, where it is situated over PM. 2 instead of lying over PM. 1.

The palatal view, fig. 5, B, emphasizes the difference of the position of the tooth-rows, and shows the more advanced position of the palatine border.

Comparisons of skulls have, as OSBORN has pointed out, to be kept within groups, so that if the terms brachycephaly and dolichocephaly are retained for the rhinoceroses it must be on the understanding that there is no rhinoceros known which is brachycephalic or, more correctly, brachycranic in the sense that a horse's skull is. Like the

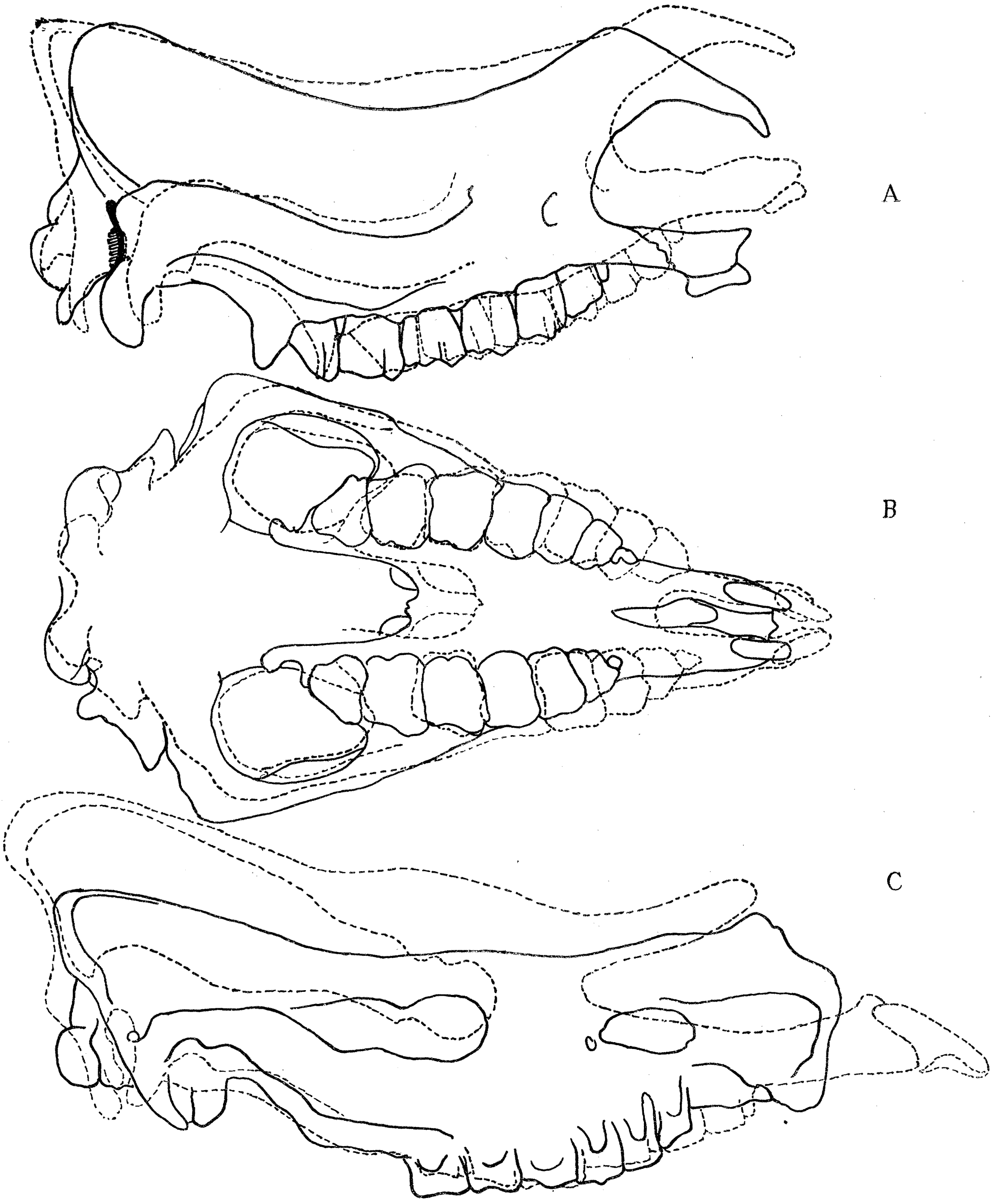

FIG. 5.—Outlines of skulls reduced to a common occipital-orbital length. (A) *Rhinoceros sumatrensis* (dotted line) superimposed on *R. sondaicus* (unbroken line); (B) The same skulls in palatal view; (C) *Aceratherium incisivum* (dotted line) superimposed on *R. etruscus* (unbroken line).

Titanothere skulls the rhinoceroses are all dolichocranic and brachyopic in varying degree. *

If two skulls which by general agreement are called dolichocephalic, viz., *Aceratherium incisivum* and *Rhinoceros etruscus*, are compared, fig. 5, C, it can easily be seen that they are made up in quite different ways. *A. incisivum* has a long skull, the length of which is largely made up by the extension of the premaxillary region.†

The nasals, on the other hand, are short, and the nasal notch, over the front of M. 1, lies as far back as in any rhinoceros ; so that, if the front border of the orbit is considered in its relation to the whole skull (about half-way between the two ends), the condition could be described as mesaticephalic. If the position of the nasal notch is considered, it is brachyopic. In fig. 5, C, it is superimposed upon the skull of *R. etruscus*, another type of elongated skull. Here the premaxillary region is shorter, but the nasals are longer, and the nasal notch is situated as far forward as the second premolar instead of lying over the fourth. In both skulls the occiput slopes backwards at approximately the same angle. The tooth-series as a whole is considerably shorter in *R. etruscus*, but the relative position of the series, the third molars coinciding, is much the same. As the height of the cranium, in proportion to the condylar-orbital length, is much the lower in *R. etruscus*, so is the skull by comparison the more dolichocranic. The facial region, taking the forward nasal notch as the guide, is long and the skull is dolichopic. The whole skull, therefore, is justly to be termed dolichocephalic.

If the depth of the cranium is taken into consideration that of *A. incisivum* being much deeper than *R. etruscus* is less dolichocranic and this type of skull might therefore be considered as sub-dolichocranic. Its full description, if not too cumbrous, being sub-dolichocranic/brachyopic.

To go to the other extreme, in order to find a standard for a brachycephalic skull, it is necessary for the skull to be as high as possible when reduced to the standard occipital-orbital length ; the length of the facial part being for the moment immaterial. Of several species examined for this purpose, *R. unicornis* has been found, on the whole, to furnish the best example.‡

Fig. 6 shows this skull superimposed also on that of *R. etruscus*, and thus gives the extremes between the dolichocranic and brachycranic conditions. The criteria of the greater brachycrany are the greater height, the upright occiput and the greater depth

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* Certain early skulls, *e.g.*, *Hyrachyus agrarius* (OSBORN, 1908, Plate XIIA), show a length from the front of the orbit to the end of the premaxillæ equal to the length from the orbit to the condyle. When the front edge of the orbit thus occupies a position midway between the ends of the skull it may justly be termed mesaticephalic. I can find no example of this in the true rhinoceroses. *Trigonias osborni*, for instance, a very early form, is strongly dolichocranic (GREGORY and COOK, 1928, Plate I).

† In the original illustration by KAUP (1831) this region is incomplete and perhaps overestimated in the restoration but, under any circumstances, the length must have been considerable.

‡ *Aphelops* another "brachycephalic" form is in reality less so because, in spite of its short facial region, the cranial region is much shallower.

of the zygoma. The facial region is shorter, though not by much, and the position of the nasal notches almost coincides. The tooth-rows, practically the same in length on the scale of reduction used, show a considerable posterior movement in the brachycephalic skull. Other species have also been figured for the purpose of comparison or because the genera they represent have a direct bearing on some of the Baluchistan forms described in this paper, figs. 7, 8.

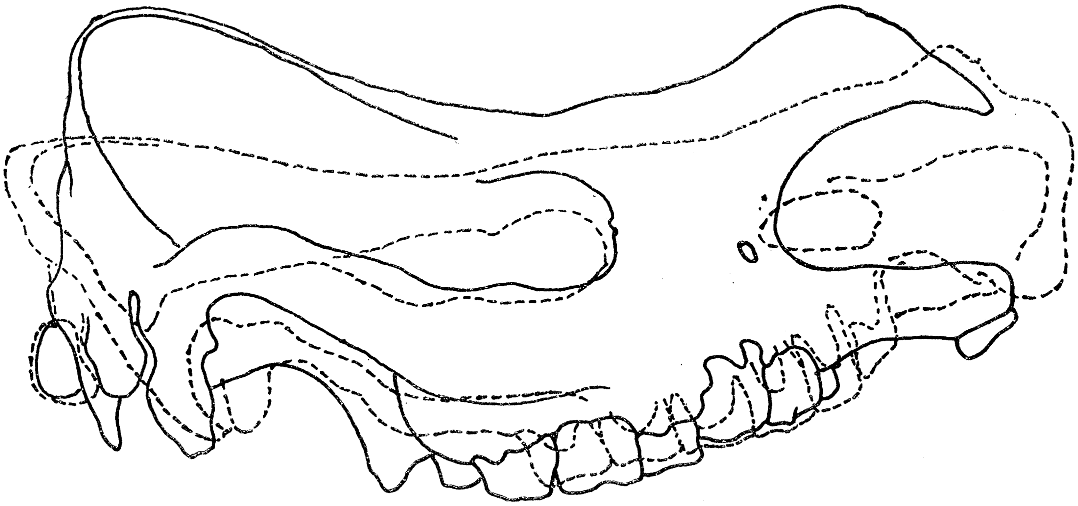

FIG. 6.—Outline of the skull of *Rhinoceros etruscus* (dotted line) superimposed on that of *R. unicornis* (unbroken line).

It appears that no single term suffices to describe the skull proportions and that, when the cranial parts are reduced to a common length, the greater comparative height of the cranium is the measure of its brachycrany and that the advanced or recessed position of the nasal notch is the more convenient measure of its dolichopy or brachyopy. Other rhinoceros skulls of many shades of difference in shape fall between the examples here quoted and illustrated as the extremes. Whether they can usefully be classified under descriptive terms is perhaps questionable.

Teleoceras, fig. 7, A, has been described by MATTHEW as mesaticephalic. If it is compared with *Aphelops* it has the same length proportion of cranium and face, but is considerably lower. Compared with the skull of *R. unicornis*, used here as the standard of brachycephaly, it is lower still, but the facial region is much shorter than the standard, and the premolar region of the teeth lies further back owing to the reduction in size of the anterior premolars. *Teleoceras*, fig. 7, A, therefore, is dolichocranic and strongly brachyopic. *Brachypotherium aurelianensis* var. *gailiti* (BORISSIAK), fig. 7, D, has a skull of similar general form.*

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* The terms brachy- and dolichocephalic are used in this account as expressions of a height and length ratio and not in the sense, used in human anatomy, of breadth and length. It seems inadvisable, however, to introduce any new terms.

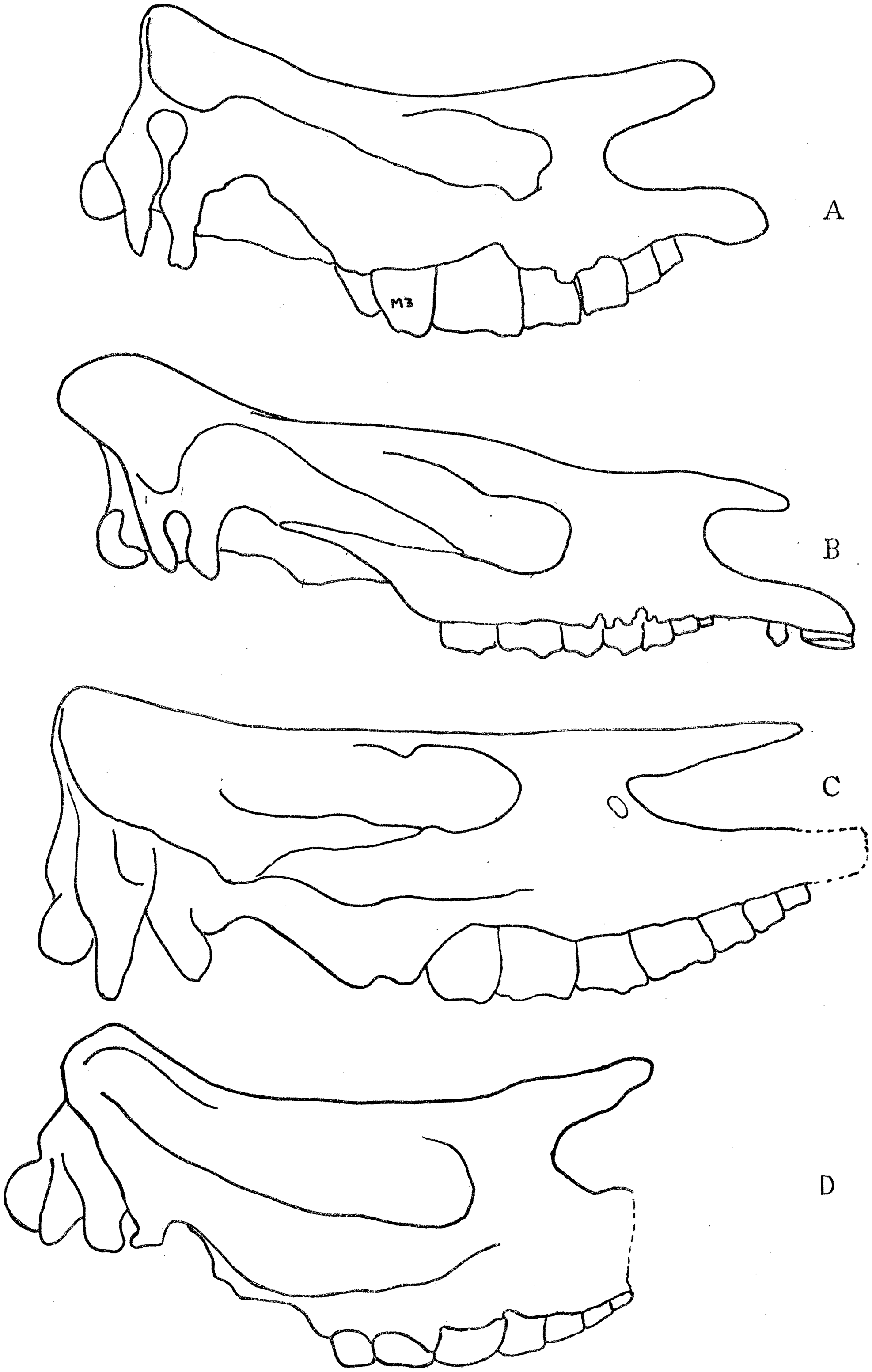

FIG. 7.—Outlines of skulls reduced as in the previous figures. (A) *Teleoceras fossiger* (after MATTHEW), (B) *Cœnopus platycephalum* (after OSBORN); (C) *Chilotherium persicæ* (from a drawing of a specimen in Vienna, kindly supplied by Professor ABEL); (D) *Brachypotherium aurielanense* var. *gailiti* (after BORISSIAK).

DESCRIPTION OF SPECIMENS OF RHINOCEROSES OTHER THAN *Baluchitherium* AND *Paraceratherium*.

Up to the present time the following five species of rhinoceroses have been described from the Bugti Hills of Baluchistan.

Aceratherium blandfordi var. *majus* (LYDEKKER, 1884, p. 2).

Placed in the genus *Rhinoceros* by LYDEKKER (1886, p. 154), *Teleoceras* by PILGRIM (1912, p. 30), and MATSUMOTO (1921, p. 91 (17)). *Rhinoceros* by MATTHEW (1932, p. 439). *Chilotherium* by RINGSTROM (1924, p. 80) and MATTHEW (1929, p. 508).

" *Rhinoceros* " *blandfordi* var. *minus* (LYDEKKER, 1884, p. 3).

Placed in the genus *Diceratherium* by PILGRIM as *D. naricum* n. sp. (1912, p. 24). By MATSUMOTO as *D. minus* (LYDEKKER) (1921, p. 91 (17)).

Diceratherium shahbazi (PILGRIM, 1912, p. 25).

Placed as a member of a " *Pro-Chilotherium* " group by MATTHEW (1929, p. 510), together with *D. minus*.

" *Rhinoceros* " *sivalensis* var. *gajensis* (LYDEKKER, 1884, p. 5).

Placed as *Aceratherium gajense* by PILGRIM (1912, p. 28).

Teleoceras fatehjangensis (PILGRIM, 1912, p. 32).

To this list must now be added some further forms in the present collection, which appear to be different from those already recorded from the district.

It is obvious, from the list given above, that there is a wide divergence of opinion as to the generic position of these species, and this serves to emphasize the fact that the genera and species of rhinoceroses from the Oligocene and Miocene deposits of Europe and Asia are extremely confused. This is due to several causes; to the too frequent imperfection of the material on which to work, to the non-recognition of the extent to which variation can occur within a species,* to a lack of an adequate succession of forms in time, and finally, the greatest obstacle of all, to the difficulty of deciding on what characters, among a number that show only shades of difference, one should rely on when founding generic distinctions.

With these various difficulties in mind the specimens from Baluchistan may be described and named as follows:—

Aceratherium blandfordi (LYDEKKER, 1884, p. 2, Plate I, fig. 6 and Plate II, figs. 1–3).
= *A. blandfordi* var. *majus* (LYDEKKER, 1884, p. 10, Plate I, figs. 1–2).
= *Rhinoceros blandfordi* var. *majus* (LYDEKKER, 1886, p. 154).
= *Teleoceras blandfordi* (PILGRIM, 1912, p. 30, Plate VII, figs. 4–7) (MATSUMOTO, 1921, p. 91 (17)).
= *Chilotherium blandfordi* (MATTHEW, 1929, p. 508) (RINGSTROM, 1924, p. 75).
Figs. 34–36, Plate 67, and figs. 9, A–G, and 12, *C*.

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* How great this variation can be has been very clearly shown by GREGORY and COOK (1928) in their work on the genus *Trigonias*.

Fig. 8.—Outlines of skulls reduced as in the previous figures. (A) *Aceratherium incisivum* (after Kaup); (B) *Aceratherium depereti* (after Borissiak); (C) *Teleoceras* (*Brachypotherium*) *aginense* (after Roman).

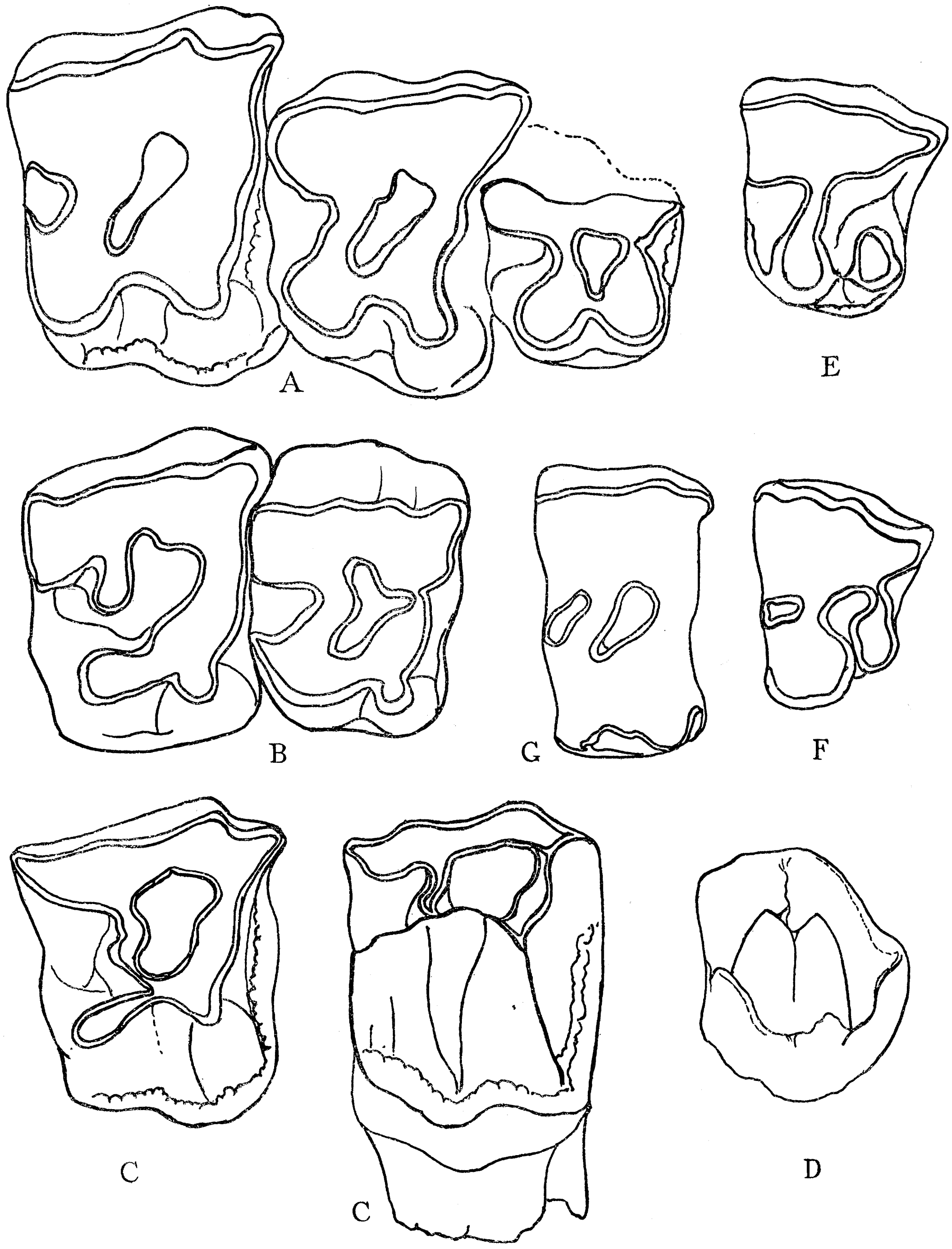

Fig. 9.—Premolars of *R. blandfordi* natural size. (A) Second to fourth premolars rather worn; (B) Third and fourth premolars lacking in cingulum; (C) Fourth premolar, very slightly worn, crown and inner side views; (D) Second premolar, unworn, in side view; (E—F) Second premolars, moderately and very much worn; (G) Fourth premolar much worn. Figs. E–G show resorbtion due to age.

Lydekker (1881, Plate 6, fig. 1) described a battered fragment of a left maxilla of a small rhinoceros from the Punjab as akin to *R. palæindicus* or, alternatively, as representing a possible new species. Later (1884, Plate I, fig. 6) he described another rather larger maxilla from Baluchistan as *Aceratherium blandfordi* var. *majus* and a smaller maxilla and lower jaw (1884, Plate II, figs. 4, 5), from the same locality, as *A. blandfordi* var. *minus*, to which variety he also ascribed the Punjab specimen. In 1886 he transferred the species, without comment, from the genus *Aceratherium* to *Rhinoceros*. The naming of the two varieties had the effect of leaving the name *A. blandfordi* without any specimen designated to represent the type form and, as subsequent workers have thought that the two varieties represent different species and even different genera, the question arises as to which of the two is to be considered as the type form. PILGRIM, in his memoir on the vertebrate fauna of the Gaj series in the Bugti Hills cited above takes the view that the larger teeth are to be regarded as the type (1912, p. 31), and this solution is adopted here, so that the three molars figured by LYDEKKER on his Plate I, fig. 6, 1884, are to be chosen as the lectotype of the species. These three teeth are considerably worn down and are not very satisfactory as material on which to form a specific determination. PILGRIM (p. 30, 1912) was not able to add much to our knowledge of this species, owing to the poor condition of his material. The specimens in the present collection are numerous and the quality fair. Some details can therefore be added, though a complete description is still wanting.

Of these the most complete is a fragment of a skull with three premolars and three molars on the left side and the same on the right, except for the second premolar, fig. 34, Plate 67. The teeth are all rather worn down and in places much chipped. The ends of the skull are missing, but part of the side of the face is preserved, enough to show that the nasal notch was considerably recessed, lying as far back as the fourth premolar. This feature, together with the compression of the anterior teeth to be mentioned later, suggests a brachyopic skull. The upper surface of the skull has been sheared off and is covered with an " iron pan " of sand and small pebbles characteristic of certain deposits at Kumbhi where the specimen was found. After making due allowance for some crushing, the orbit appears to be compressed, which suggests an incurved roof like that of *Brachypotherium aurelianense* var. *gailiti* (BORISSIAK, 1927, *a*, Plate I, fig. 1, p. 287), from Turgai.

In the palate the three molars correspond closely with the figure of the type specimen, and there is no reasonable doubt as to the specific identity of the two specimens. The presence, therefore, of the premolar series becomes valuable as affording some guide as to the generic position of the form. The premolars are worn down and damaged, but enough remains to enable a number of other fragments, containing molars and premolars in various stages of wear, to be matched, and so to give a reasonably complete account of the dentition from the second premolar to the third molar.

The premolars are all quadrate, hypsodont, with the outer wall rather upright and, being compressed, considerably broader than long. This compression is more noticeable in old, than in younger, specimens. The protolophs and metalophs are parallel, a well-marked cingulum is present, as it is in the molars, and faint traces of a crochet and crista occur. The first premolar is represented by its roots only, and no account can be given of its crown structure. Of the second, there are several specimens in all stages of wear. Fig. 9, D, E, F, shows an unworn, a moderately worn, and a very old tooth. In the quite unworn state the tooth is sub-triangular owing to the overhang of the front and hind borders of the ectoloph which, being used up as the tooth becomes worn down, gradually becomes rectangular. The protoloph in its upper part is separated from the protocone region of the ectoloph but joins it further down. The level at which this junction takes place is somewhat variable and in one specimen it remains separate to the bottom of the valley.

The third premolar, fig. 9, A, B, in the unworn state, shows that it is a considerably hypsodont tooth with the "protocone," *i.e.*, the deuterocone, well constricted, and the proto- and metalophs joined high up on the inner border, so that a very slight wear produces an inclosed space instead of an open valley.

The fourth premolar, fig. 9, A, B, C, G, in an unworn state, has the two lophs joined still higher up. The metaloph slopes forward towards the protoloph and joins it between the deuterocone and tetartocone. Lower down in the level of the tooth the metaloph swings backwards to some degree to that, in a worn tooth, the two lophs appear to be more parallel. The protoloph also swings round and ends in the tetartocone which stands out beyond the point of junction of the two lophs. This tooth is, therefore, less molarized than the preceding ones, and molarization must be considered as proceeding from front to back. In this there is an agreement with the specimen described by PILGRIM (1912, p. 31), who also points out that this is in reverse order to the direction taken by *R. blandfordi* var. *minus*. On this, and on other characters, PILGRIM has rightly decided that the two forms are different species.

Certain separate, and very worn, premolars show an extraordinary reduction in breadth, fig. 9, G, F, which is clearly caused by resorption from mutual pressure. The enamel and a considerable amount of the dentine has become dissolved away so that the proportion of length to breadth is much reduced. The total length of the whole tooth-series would, therefore, alter very much as the age of the animal increased. This evidently is also a characteristic of "*Aceratherium*" [*Chilotherium*] *blandfordi* var. *hipparionum* KOKEN and of other species of the genus *Chilotherium* (see RINGSTROM, 1924).

Indications of a certain amount of minor variation in the cingulum and in the stage of evolution is sufficiently shown by the figures. It is not greater than might be expected.

In the absence of any definitely known lower jaws, premaxillæ, feet and other parts of the skeleton this animal is difficult to place generically but, from the evidence now at hand, it is clear that it cannot be fitted into any of those genera among which it was formerly classified. On the structure of the molar teeth alone it might easily be placed in any of them, which only serves to show that such characters as a strongly constricted protocone, a large antecrochet, a cingulum, etc., are features too widely spread to afford any safe guide to generic distinction. The somewhat earlier stage of the premolar evolution does not necessarily prevent this form from being considered as belonging to the ancestral line of such forms as *Teleoceras* or *Chilotherium* which are, typically, genera of later Pliocene age, but little evidence can be adduced that this is so.

Considerable importance must be attached to the order of molarization. It proceeds, as shown above, from in front backwards. The rhinoceroses known to have this type of premolar evolution are found in the American genus *Cœnopus* (and presumably, therefore, it took place in the genera derived from *Cœnopus*, such as *Trigonias*, *Aphelops*, *Diceratherium*), and in the European genus *Epiaceratherium* to which, according to ABEL (1928), are allied the genera *Paracœnopus* and *Meninatherium* (ABEL). ABEL (1928) suggests that the Teleocerinæ, a sub-family in which he includes the genera *Teleoceras*, *Chilotherium* and *Brachypotherium*, are derived from the *Aceratherium* stock. The premolar evolution of "*A.*" *blandfordi*, therefore, excludes it from any connection with these genera. MATTHEW (1931), however, disagrees with this view, and classifies *Chilotherium* as a branch of the *Aphelops* line. In most of these genera molarization is complete, and there is no guide as to the order of evolution, except that in the figure of *Brachypotherium aurelianense* given by BORISSIAK (1927, *a*, Plate I, fig. 1, p. 287), there is some slight indication that it has proceeded in a forward direction.

The animal here under discussion has been placed in the genus *Chilotherium* by RINGSTROM (1924) and by MATTHEW (1929), presumably on the evidence of the structure of the molars. This structure, however, the constricted protocone, the large crochet, the heavy cingulum, etc., is found in so many genera that it has little value as evidence of affinity. There is, moreover, no evidence that the lower jaw, to which a symphysis is here referred, fig. 10, A, had that exceptionally wide symphysis which is such a leading characteristic of *Chilotherium*. The structure of the feet and skeleton, from which much information might be obtained, is entirely unknown. MATTHEW (1929) states that "*Chilotherium*" *intermedium* (LYDEKKER) is close to "*C.*" *blandfordi* (LYDEKKER). The type of the first-named species is no more than a second upper molar, but MATTHEW (1929, fig. 32, p. 508) refers to this species a specimen in the Indian Museum. According to him it is doubtful if the two species are really separable. They differ only in that the first-named has a more prominent antero-external pillar and a less constricted protocone. In the light of the specimens here described it can be seen that *C. intermedium* is much more advanced in the evolution of the premolars, in the lesser development of the cingulum and in the development of a much larger crochet on the molars, and appears therefore to be a separate species. All that can be said, therefore, about the generic position of *R. blandfordi* is that it appears to have been derived from some *Cœnopus* stock and that, as far as the evidence goes, there is nothing to prevent it from being regarded as having some affinity with *Aphelops*. For the present, and until more complete material is collected, it must remain as a "Rhinoceros" *sensu lato*.

Chilotherium smith-woodwardi (Forster-Cooper).

Aprotodon smith-woodwardi (Forster-Cooper, 1915, p. 408, figs. 4, 5).

Two fragments of symphyses of lower jaws were originally described as representing a new genus of hippopotamus, a view to which the general outline of the specimens lent some colour. The subsequent discovery by Ringstrom (1924) of a genus of rhinoceroses, *Chilotherium*, with an exaggerated width of the symphysis of the lower jaw as its chief character makes a withdrawal of the original ascription necessary. In the light of this later discovery Vaufrey (1928) has pointed out reasons, which are

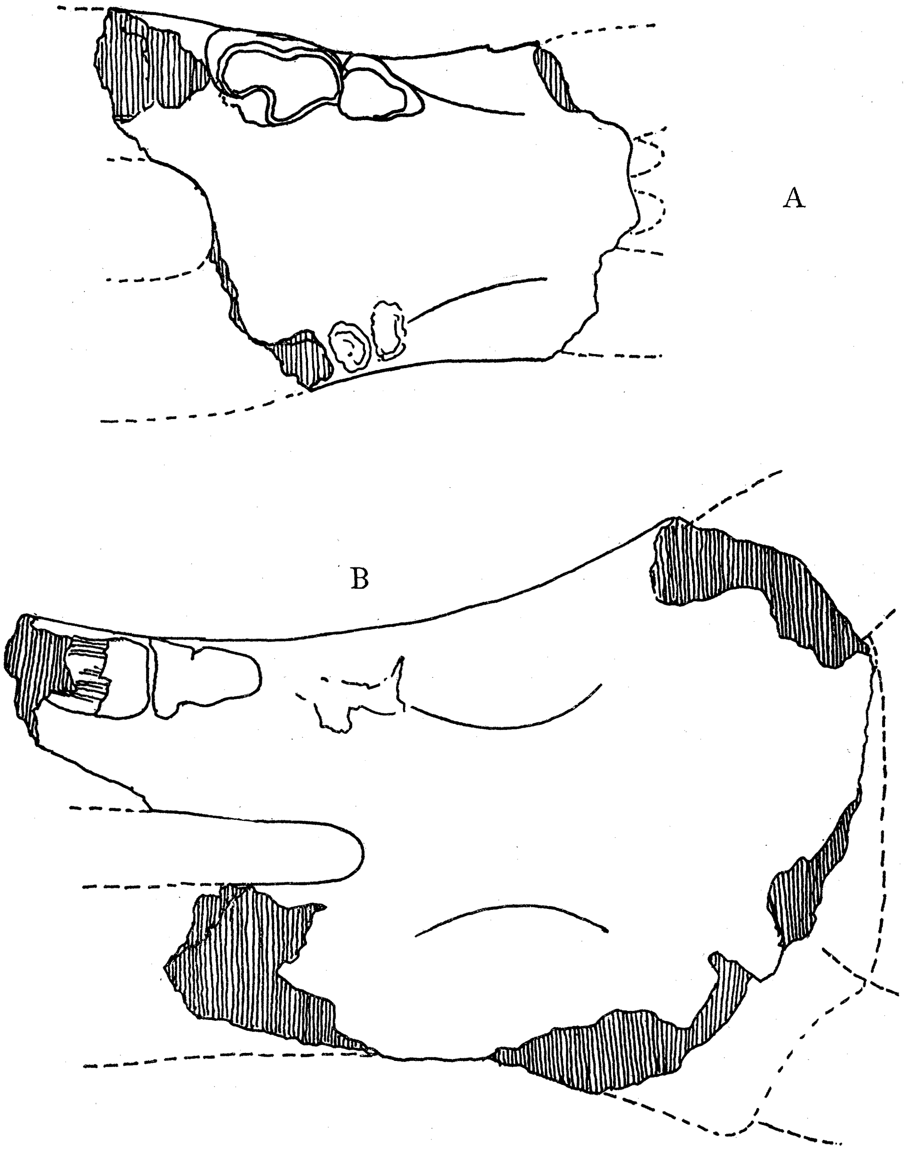

Fig. 10.—Portions of mandibular symphysis × $\frac{1}{2}$. (A) Attributed to *R. blandfordi*; (B) *Chilotherium smith-woodwardi.*

here accepted, against the view that these fragments be considered as belonging to hippopotamus and in favour of their belonging to *Chilotherium.*

Of the two specimens one has already been figured (Forster-Cooper, 1915, p. 408, figs. 4, 5). The other specimen is almost identical, except that it shows the much-worn remains of the anterior teeth, and is here figured for the first time, fig. 10, B. It shows the same great breadth across the front of the jaw, a socket for the large tusk which is oval in section, and a total absence of any other incisors. Of the premolars all that can be said, so far as the condition of the specimen will allow, is that the well-worn stumps appear to represent the first and the anterior half of the second, and that the shape is consistent with that of a rhinoceros.

If these specimens are rightly placed in the genus *Chilotherium*, and there seems to be little reason to doubt the correctness of this view, the chief point of interest lies in the early appearance of the genus in such a fully-developed stage. The type species of the genus comes from the Pliocene of China, while the level of the Churlando beds of Baluchistan, in which the present specimens were found, is not later than the Lower Miocene; yet, so far as one may judge on the rather scanty evidence, the Baluchi form is as fully advanced as any of the genus. It is clear, moreover, that such a form as *R. blandfordi* cannot be placed in the same genus, as is sometimes done, nor can it be regarded as an ancestral stage seeing that it comes from a level that must be regarded as approximately the same as that of the Churlando bed.

Aceratherium abeli new sp. Figs. 11, A, B; 12, B; and fig. 25, Plate 65, fig. 31, Plate 66.

This specimen consists of a skull of a young adult with the fourth premolar and third molar just coming into wear. The premaxillary and nasal regions and also the outer parts of both zygomatic arches are lacking. The rest of the skull is in fairly good condition, the lower jaws being found in association with it in the bone bed at Churlando.

The skull is low and flat, fig. 11, A, B, and shows no hollow between the orbits and occiput. From a point just behind the orbits to the back the upper surface is in good condition and is apparently uncrushed. From the orbit on each side a low ridge runs back to join its opposite, and the two continue as a single sagittal ridge for some distance. This ridge then divides, and each part continues as the outer border of a flat, spreading, and backwardly-directed flange which overhangs the forwardly-sloping occiput and the condyles. This border runs downwards, and then forwards, to the posterior root of the zygomatic arch.

In side view, fig. 11, A, the face is well preserved in the region over the premolars, and here the antorbital foramen, situated over the fourth premolar, does not lie on the side of the face and directed forwards as is more usual, but points upwards. This indicates a flattened premaxillary region and a much recessed nostril. The orbits are flat, and the brow ridges well marked. The paroccipital and post-tympanic processes are directed forwards and their lower parts are closely pressed against the zygomatic process, a feature which seems to be natural and not due to distortion, as is shown by the wide circular opening above for the external auditory meatus.

The palate with the teeth is well preserved. The first premolar is too worn to allow any description, except that it has the usual triangular pattern. The remaining premolars are all fully molarized. The second show parallel lophs without any sign of crochet or cingulum while the third and fourth have a small crochet and a weak cingulum on the internal side confined to the opening of the valley between the lophs. The molars are like the premolars in general structure, but here the cingulum is confined to a small anterior shelf, and none is present on the inner border. The crochets are moderately developed, and there is no crista. The protocones throughout are only weakly constricted.

FIG. 11.—Skull of *Aceratherium abeli* n. sp. (A) In side view; (B) the upper surface × $\frac{1}{4}$.

The measurements in millimetres are as follows :—

	PM. 1.	PM. 2.	PM. 3.	PM. 4.	M. 1.	M. 2.	M. 3.	
Length . . .	26	32	37	41	49	51	50	(approx.).
Breadth . .	18	37	45	50	51	61	?	
Height . . .	—	—	—	38	—	45	—	(These two teeth are unworn.)

The teeth may therefore be described as mesodont.

The lower jaws show the tusks partly erupted and the seven cheek teeth. The tusks are long, procumbent, sharply pointed, with a flat upper surface of wear and a rounded

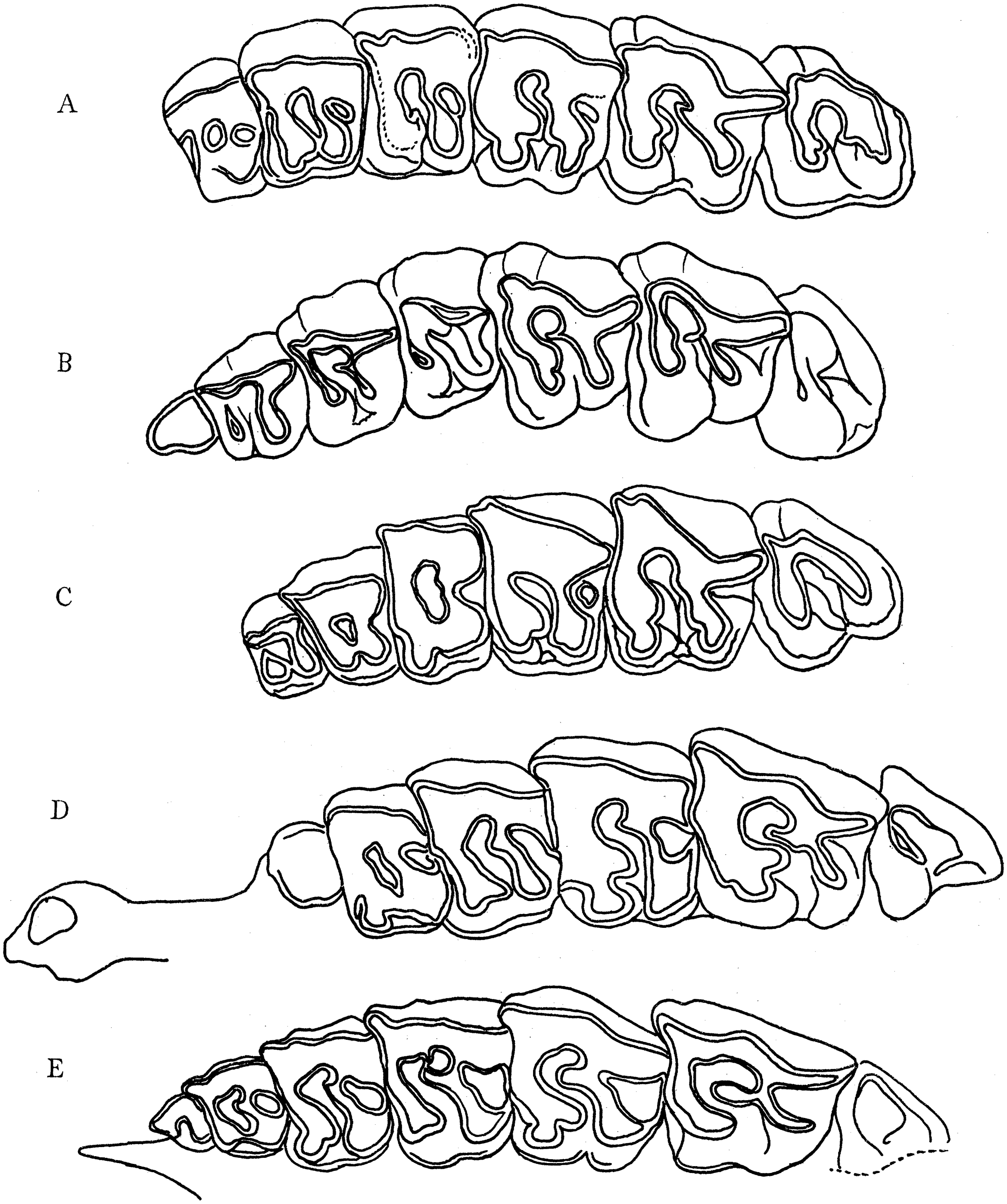

FIG. 12.—A series of upper dentitions for compaison × $\frac{1}{2}$. (A) *Brachypotherium aurelianense* var. *gailiti* (after BORISSIAK); (B) *Aceratherium abeli* n. sp.; (C) *Rhinoceros blandfordi* from the specimen described in this paper; (D) *Teleoceras fossiger* (after MATTHEW); (E) *Chilotherium andersoni* (after RINGSTROM).

border below. Between them is a pair of small sockets for median incisors, which appear to have been pushed out by the growth of the tusks. The first premolars are small, almost conical teeth with a single root barely divided by a groove on each side the structure of the remaining molars is sufficiently shown by the illustration, fig. 32, Plate 66.

In shape the ramus is only slightly bowed under the molars, and the symphysis but little turned up. The posterior angle is strongly marked and the external border has a markedly thickened rim.

The dentition in general shows considerable resemblance to that of "*Teleoceras*" *aginense*, as figured by MAYET (1908), and to *Aceratherium Depereti* (BORISSIAK, 1927, *b*). From the latter species the present specimen differs considerably in the proportion of the skull, and is undoubtedly separate, but is placed tentatively in the same genus. I have taken the liberty of naming it after my friend Professor OTHENIO ABEL.

In fig. 12 are shown for comparison the outlines of the upper dentitions of *B. aurelianense*, *R. blandfordi*, *A. abeli*, *C. andersoni* and *T. fossiger*.

Specimens incertæ sedis.

There remain for description a number of specimens which show the presence in these deposits of at least five or six further different forms of rhinoceroses. They all have points of interest but, owing to their fragmentary condition, and often to the bad state of preservation, it is not possible to place them with any certainty. Some are tentatively ascribed to species already known, others may represent new forms, though for the reasons given no new specific names are proposed.

Fig. 13, A, shows a second premolar followed by the inner parts of the third and fourth. The posterior of the three is the less molarized, and molarization is proceeding from in front in a backwards direction. Except for a small crenelated shelf on the anterior side of the last two teeth, there is a total absence of cingulum. These teeth lie in a fragment of the side of the face which shows a very considerable height.

Fig. 13, B, shows the second and third premolars and the outer part of the fourth. In this specimen the teeth are much worn down and in appearance are similar in size and pattern to those of *R. blandfordi*, but differ in having a well-marked crista which, showing as it does in teeth that are worn almost flat, must originally have been of considerable size.

Fig. 13, C, shows a second and third premolar of a considerably larger animal. The fragment containing these teeth shows a space, somewhat obscured by intractable matrix, in which the first premolar lay. The teeth are much broader than long, moderately worn, and not in very good preservation. The outer and inner walls slope together, and thus show that the teeth must have been low—on the brachydont side of mesodont at the least. The second premolar is sub-triangular, and the third trapezoidal. In both the lophs join high up, and molarization is very incomplete. A well-marked crista is present, but little or no crochet or antecrochet. The cingulum is totally absent. The second premolar measures 41 mm. in length and 53 in breadth, the third 46 and 66 mm., so that this animal cannot be placed with "*Teleoceras*" *fatehjangense* (PILGRIM), a species to which the next specimen, a smaller animal, probably belongs. *Teleoceras fatehjangense* (PILGRIM, 1912) comes from a deposit in the Punjab of equivalent age to the Bugti beds, and the type, and only, specimen consists

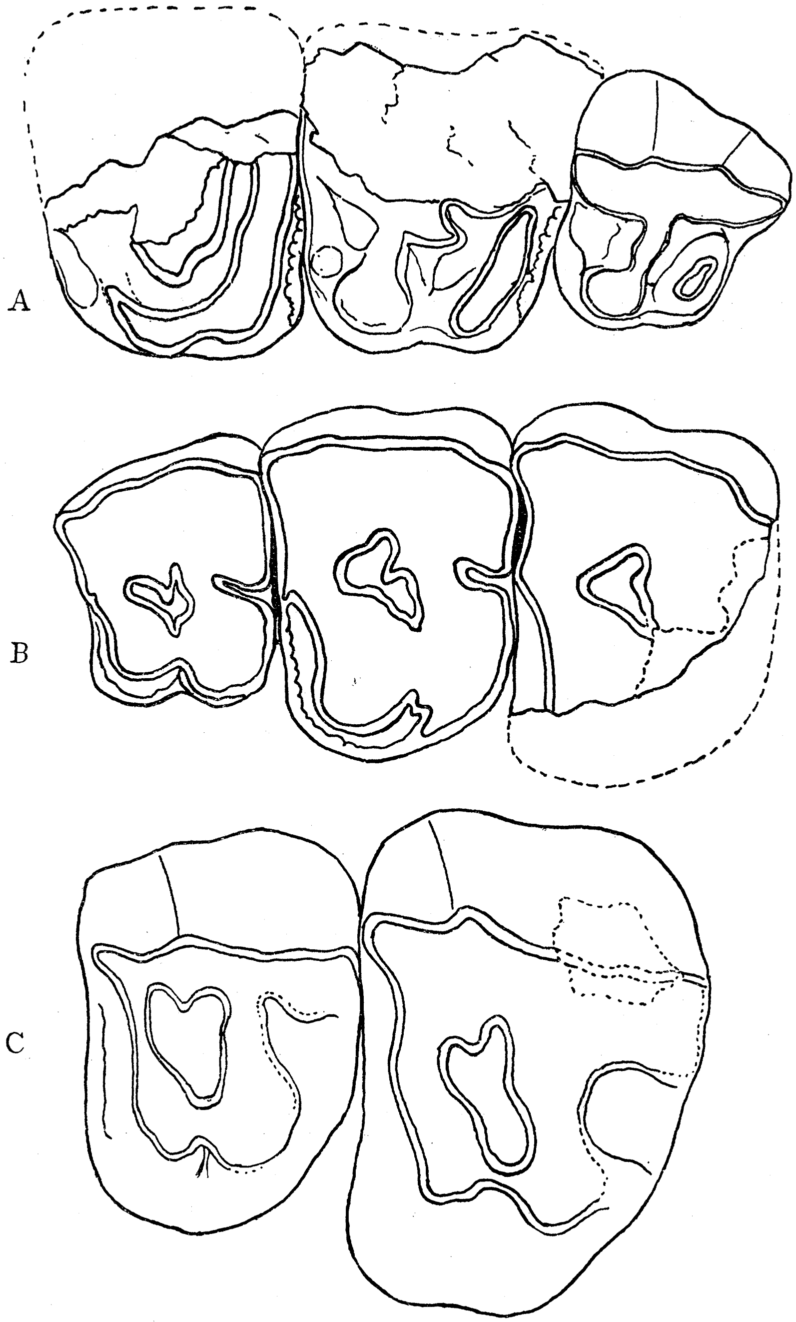

FIG. 13.—Premolars of three species *incertæ sedis*. Nat. size.

of a fourth premolar and two molars. The present specimen, fig. 14, which is in poor condition and considerably worn, appears to have the same series of teeth, and therefore a direct comparison with PILGRIM'S specimen is possible. The premolar shows that the lophs join rather high up. In the molars there is evidence that the protocones are constricted. No trace of crochet is visible. The cingulum is confined to a small piece at the opening of the valley between the lophs.

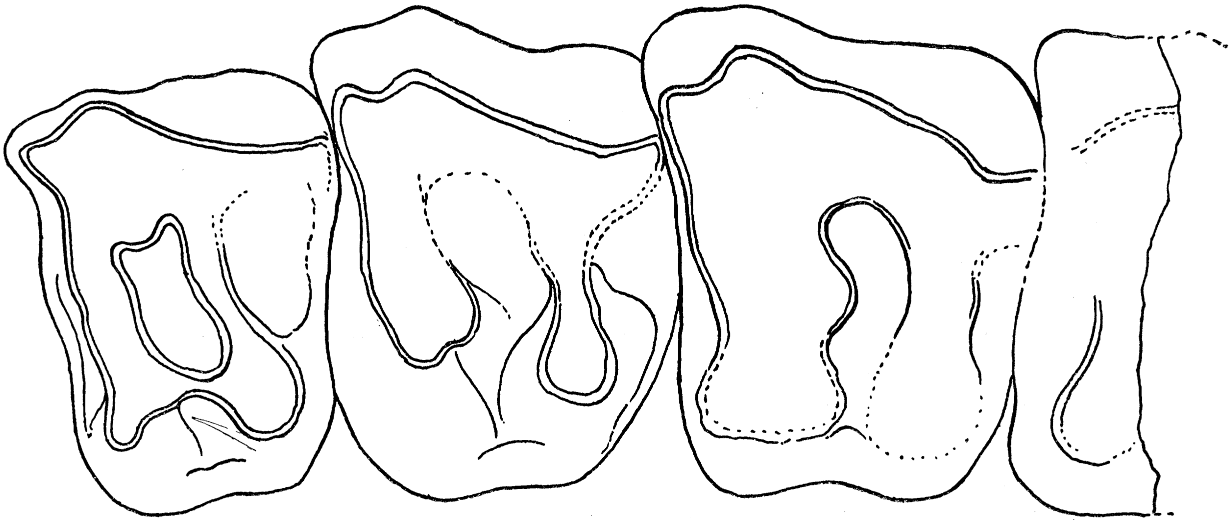

FIG. 14.—The second to the fourth premolars and part of the first molar, referred to *Teleoceras fatehjangense* (PILGRIM). Nat. size.

In fig. 24, Plate 64, is shown a second and third premolar unlike any others in the collection. The second is square, the third rather broader than long, and both teeth are surrounded by a very heavy cingulum on the front and inner sides. Molarization is complete, and the lophs are parallel and completely divided from one another. The protocones are not constricted at all, and there is a trace of a crochet and crista on the third premolar. These teeth are a little smaller than those of *R. blandfordi*, and differ materially in structure. There is some resemblance to the teeth figured by LYDEKKER (1884, Plate II, fig. 4) as *R. blandfordi* var. *minus*, except that in that form the anterior teeth are not molarized. These teeth correspond very closely with those of the type specimen of *Aceratherium albigense* as figured by ROMAN (1911). Premolar 2 measures 24 mm. in length and 27 in breadth, premolar 3 measures 27 and 34 mm. respectively.

That a still smaller species of rhinoceros existed in this locality is shown by several fragments of upper and lower jaws that are referred to it. Fig. 26, Plate 65, shows a first and second upper molar only slightly worn, together with the front part of the third molar just erupting. The protocones are constricted, thus giving rise to a strong antecrochet. The crochet is well marked in its upper part but fades away lower down, so that in a much used tooth it is little in evidence. There is a strong cingulum-shelf on the front border of the teeth, but none elsewhere. A slightly worn third upper molar, fig. 29, Plate 65, clearly belongs to this species. It has a cingulum cusp at the internal opening of the median valley. A rather more worn one is also shown, fig. 29, Plate 65, and a milk molar, fig. 30, Plate 65. Three upper milk teeth, a little smaller, fig. 28, Plate 65, are referred to this species, as are several fragments of the lower jaw, fig. 15. This animal appears to have been about the size of *Ceratorhinus tagicus* (ROMAN, 1907), and the upper teeth show practically no difference from those figured by ROMAN. BORISSIAK (1921) describes and figures a somewhat similar jaw of a small animal from the *Indricotherium* beds of Turgai, which he tentatively places as a *Diceratherium.*

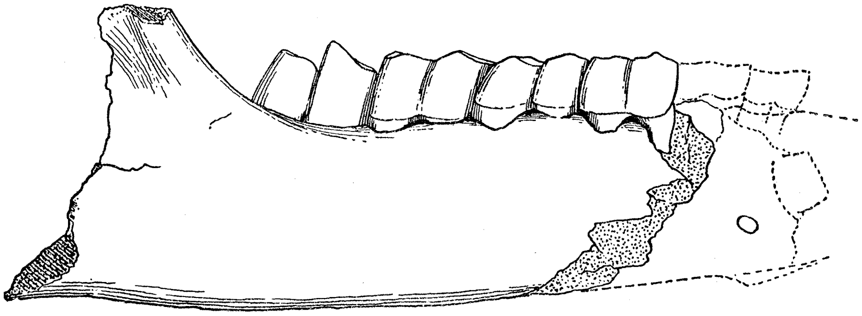

FIG. 15.—Lower jaw referred to *Ceratorhinus tagicus* (ROMAN). ½ Nat. size.

Some Milk Dentitions.

Three upper milk molars, fig. 16, considerably worn which, in shape and, as far as can be seen, in pattern are indistinguishable from those of *Paraceratherium bugtiense* except that they are considerably smaller (about 25%). Professor ABEL, to whom this specimen was submitted for his opinion, considers that it is about the stage of *Protaceratherium minus*. *Paraceratherium* and *Protaceratherium* are both in about the same stage of dental evolution.

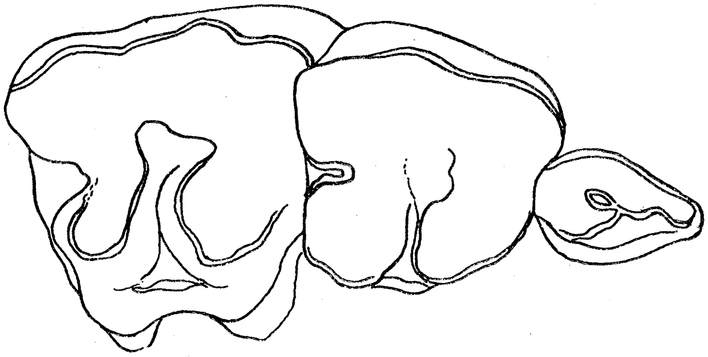

FIG. 16.—Milk teeth of a specimen *incertæ sedis*. Nat. size.

Three upper milk molars, the first molar erupted but quite unworn and the third premolar excavated from its alveolus, figs. 37, 38, Plate 67. The milk teeth correspond with those figured by PILGRIM (1912) as belonging to *Diceratherium shahbazi*, except that there is no trace of any cingulum. The first molar has a very strong crochet which is well developed right down to the base of the valley. The parastyle is well marked, the ectoloph long, the protocone moderately constricted and the cingulum entirely absent on the inner side, being restricted to a shelf in front and a small portion on the posterior border. The third premolar, as developed from its alveolus, has the lophs joined about half way up, a well-marked crochet and a small crista absent in the upper half, but starting half way down the internal wall of the ectoloph. This specimen, if rightly attributed, supports PILGRIM'S view that *D. shahbazi* is distinct from *R. blandfordi* var. *minus*. To this last species another milk dentition is more properly to be ascribed, figs. 39, 40, Plate 67. The teeth are smaller, as they should be, the cingulum is more developed and the premolars, although still not fully grown, show that the fourth premolar is fully molarized. This milk dentition shows a fourth deciduous tooth with a well-constricted protocone and metacone, a moderately well-developed cingulum and a strong crochet and crista. The underlying fourth premolar is sufficiently developed to show that the lophs are separate, and molarization well advanced. This specimen is rather smaller than the last, but all these milk dentitions belong to rather small forms. Their actual sizes can be seen in the figures.

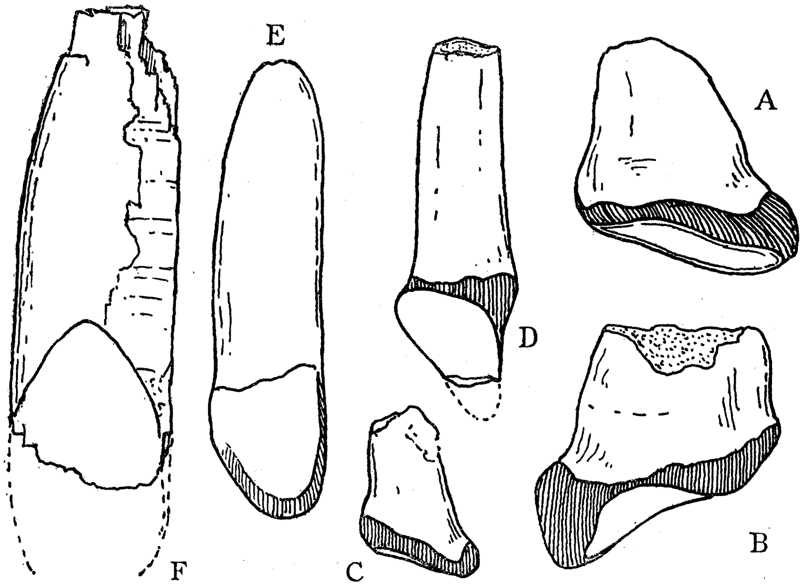

FIG. 17.—Upper and lower tusks. × ½. (A–B) Referred to *A. abeli* or to *R. blandfordi*; (C) to *C. tagicus*; (D) to *C. tagicus*; (E) to *R. blandfordi*; (F) to *Ch. smith-woodwardi*.

It is unfortunate that no skull was found with the premaxillæ in position, consequently the loose incisors figured, fig. 17, A, B, C, cannot be placed with certainty. The larger ones, fig. 17, A, B, might equally belong to *Aceratherium abeli*, which is perhaps the more probable, or to *R. blandfordi*. The small incisor, fig. 17, C, is most probably from the form referred to *C. tagicus*. A number of loose lower tusks were also found, and of these a small one, fig. 17, D, may also be referred to *C. tagicus*. The larger one, fig. 17, E, is possibly a tusk of *R. blandfordi*, and the largest of all, fig. 17, F, may be referred with some probability to *Chilotherium smith-woodwardi*.

The Bugti deposits have so far yielded very little of the skeleton of rhinoceroses other than portions of the skull and teeth. A few scattered foot bones of the smaller forms were found, and these call for no particular comment, except certain astragali which have a bearing on the systematic position of the rhinoceroses of the district. The genera *Chilotherium*, *Brachypotherium* and *Teleoceras*, among which some of the Bugti species have at one time or another been distributed, are all animals with feet shortened to some extent. MATTHEW (1932) states that in *Teleoceras* the shortening of the foot is due to shortening both of the astragalus and of the digits, while in the other two genera the shortening is in the digits alone, the astragalus being " normal." This statement is largely born out by RINGSTROM (1924, p. 59, fig. 40), who figures the astragali of these three genera and of *Aceratherium*. Fig. 18 shows four astragali of which fig. 18, A, bears considerable resemblance to that of *Brachypotherium aginense*, and may belong to *R. blandfordi* while fig. 18, B, is undoubtedly like that of *Aceratherium,* and is referred to *A. abeli*. The two smaller astragali, fig. 17, C and D, show a difference in height, perhaps due to a difference in age, and from their size can only be referred to *C. tagicus*.

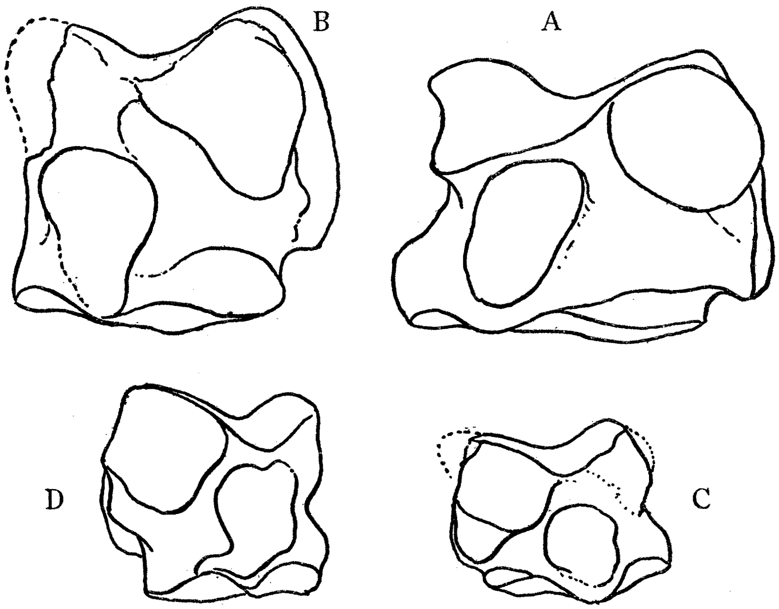

FIG. 18.—Astragali. × ½. (A) Referred to *R. blandfordi*; (B) to *A. abeli*; (C) to *C. tagicus*.

THE GENERIC POSITION OF *Paraceratherium*, *Baluchitherium* AND *Indricotherium*.

The genus *Paraceratherium* was founded (FORSTER-COOPER, 1911) on the lower jaws of a medium sized rhinoceros, found during an expedition to Dera Bugti in 1911, which had the striking characteristic of downwardly-turned tusks. This specimen was considered provisionally to be of the same species as *Aceratherium bugtiense*—briefly mentioned, without figures, as a new species by PILGRIM in 1910. This preliminary notice only states "that *A. bugtiense* is allied to *A. perimense*, but larger and more primitive in character, possessing no crochet and a hardly appreciable postfosette." As this is an insufficient diagnosis, recognition of the species must depend on his later description (1912), where he describes (pp. 26 and 27, Plates VIII, IX and X) and figures a number of separate upper and lower teeth and a fragment of a lower jaw lacking the anterior end. No particular specimen was chosen as the type of the species, so that all those figured on the three plates must collectively be regarded as the syntypes.

Some large vertebræ and limb bones, which were provisionally referred to the same species, were also found during my first expedition.

During a second expedition, in the following year, further material was found including, among a number of fragments of skulls and teeth, one which clearly belonged to the same individual as the type lower jaws of *P. bugtiense.**

With this new material it seemed that the large limb bones and vertebræ, especially the atlas, whose anterior facets were almost twice the area of the condyles of the skull, could not belong to the same species as *P. bugtiense.* Accordingly the limb bones were withdrawn from the species and made the types of a new genus and species *Thaumastotherium osborni* (FORSTER-COOPER, 1913, October, pp. 376–81, figs. 1–7), subsequently altered to *Baluchitherium osborni* (*loc. cit.*, November).

In 1915† BORISSIAK described another genus and species as *Indricotherium asiaticum*, an animal clearly closely allied to both of the Baluchi genera as BORISSIAK showed in his more detailed accounts (BORISSIAK, 1916, *b*, *c*).

Later, further material was discovered in Mongolia—an almost complete skull and several limb bones, to which the name *Baluchitherium grangeri* (OSBORN) was given (Osborn, 1923). The relationships between the genera *Paraceratherium*, *Baluchitherium* and *Indricotherium* have been somewhat debated. The separate generic rank of *Indricotherium* seems fairly established, but it remains a question whether or not *Paraceratherium* is a small form, or possibly the female, of *Baluchitherium.* The problem is not easy to decide on account of the lack of comparable specimens of the three forms. From Baluchistan come the large limb bones, vertebræ and some separate teeth referred to *Baluchitherium*, but no skull of corresponding size. From the same beds there are the type jaws, the referred skull and portions of other skulls of similar medium size, of *Paraceratherium bugtiense*, but no skeletal parts, while from Mongolia comes the large skull of *B. grangeri* with portions of the skeleton, but no lower jaws. As the teeth of all these animals show no great discrepancy in size, whether the skull

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* Both were in the same state of wear, and the skull was lying a very small distance from the position where the lower jaws were found, when work had to be stopped for the season.

† A chronological list of papers dealing with these three genera is appended on p. 613.

be large or small, and as no specimens of the smaller form known as *Paraceratherium* have been found outside Baluchistan, we arrive at an impasse.

Some comparisons are, however, still possible. Borissiak (1916, *a*, 1924, *a*) in describing his specimens notes certain points of difference in details of the tooth structure, while admitting the strong general resemblance.

These points, and others, are here collected into a list.

1. The position and arrangement of the tusks and of the contour of the lower jaws seem to be different in *Indricotherium* and *Paraceratherium*. The former, as described and figured by Pavlow (1922, *Indricotherium transouralicum*, Plate I, fig. 2), shows that the lower border of the jaw, which is apparently uncrushed, has a contour different from that of *Paraceratherium*, in being flat instead of curved (*Cp*., Forster-Cooper, 1924, fig. 7). In the type specimen of *P. bugtiense* the lower jaws are crushed, and do not give a true impression of the shape. The contour of the jaws of *Baluchitherium* is not as yet sufficiently known. *Indricotherium asiaticum*, moreover, has a pair of small incisors between the tusks. In *Paraceratherium* the two large tusks are pressed closely together at their swollen bases, and no room is left for any intermediate teeth.

2. In the premolars of *Paraceratherium* the protoloph is equal to the ectoloph in height, while in *Indricotherium* and *Baluchitherium* it joins the ectoloph at a lower level.

3. The teeth of *Paraceratherium* are rather more hypsodont according to Borissiak, a statement I am unable either to deny or confirm. He very rightly points out (1924, *a*) that comparison should be made only between unworn teeth, and unfortunately the teeth in the type skull of *Paraceratherium bugtiense* are badly worn, consequently no comparison is possible. Of the various loose teeth, however, it can be said that in some the inward slope of the ectoloph is greater than in others, which implies a more brachydont tooth (see Abel, 1910, p. 38). It can also be said that these more brachydont teeth are on the whole the larger ones and, unless this is nothing more than variation, might be attributed to *Baluchitherium*.

4. The tetartocones of the premolars are more separate and the ectoloph walls smoother in *Paraceratherium*, and the stage of molarization is more advanced.

5. There is a difference in proportional measurement. *E.g.*, the measurements in mm. of the fourth premolar were as follows :—

	Length.	Breadth.	Height.
Indricotherium and *Baluchitherium* .	61	78	60
Paraceratherium	59 to 62	66 to 75	65 to 70

In *Paraceratherium*, therefore, this tooth is somewhat higher and narrower, and though the difference is not of great amplitude it may perhaps have greater force when it is remembered that its skull is much smaller.

6. While the differences in the teeth are not great and may possibly be no more than varietal and not specific, the difference in the size of the skulls is of greater moment.

The discrepancy in this respect between *Paraceratherium* and *Baluchitherium*, and a corresponding difference implied in the size of the skeleton, is very remarkable if the animals are to be regarded as belonging to the same species. In *B. grangeri* the total length of the skull is 1286 mm., the zygomatic width 614 mm., and the condylar width 306 mm. The corresponding measurements for *P. bugtiense* are 840 (estimated), 420, and from 186 to 210 mm. (in the four skulls) respectively. These measurements, which seem less when on paper than when the skulls are placed side by side, fig. 19, A, B, do not represent the extremes, because one ramus of a lower jaw of *Paraceratherium* (Forster-Cooper, 1924, fig. 7) is considerably smaller than the type specimen, while *Indricotherium*, to judge from the cast of a metapodial in the British Museum measuring 665 mm. in length, was larger even than *Baluchitherium*. These great differences in size make if difficult, if not impossible, to regard them as sexual. Nor can they be due to racial divergence, because *Baluchitherium* and *Paraceratherium* occur, side by side, in the same bed at Churlando. In addition, when the outlines of the two skulls are superimposed, fig. 19, A, B, considerable differences in proportion are seen. Some of these have already been described (Forster-Cooper, 1924, p. 393), such as the different shape and proportions of the condyles, the tympanic opening and the

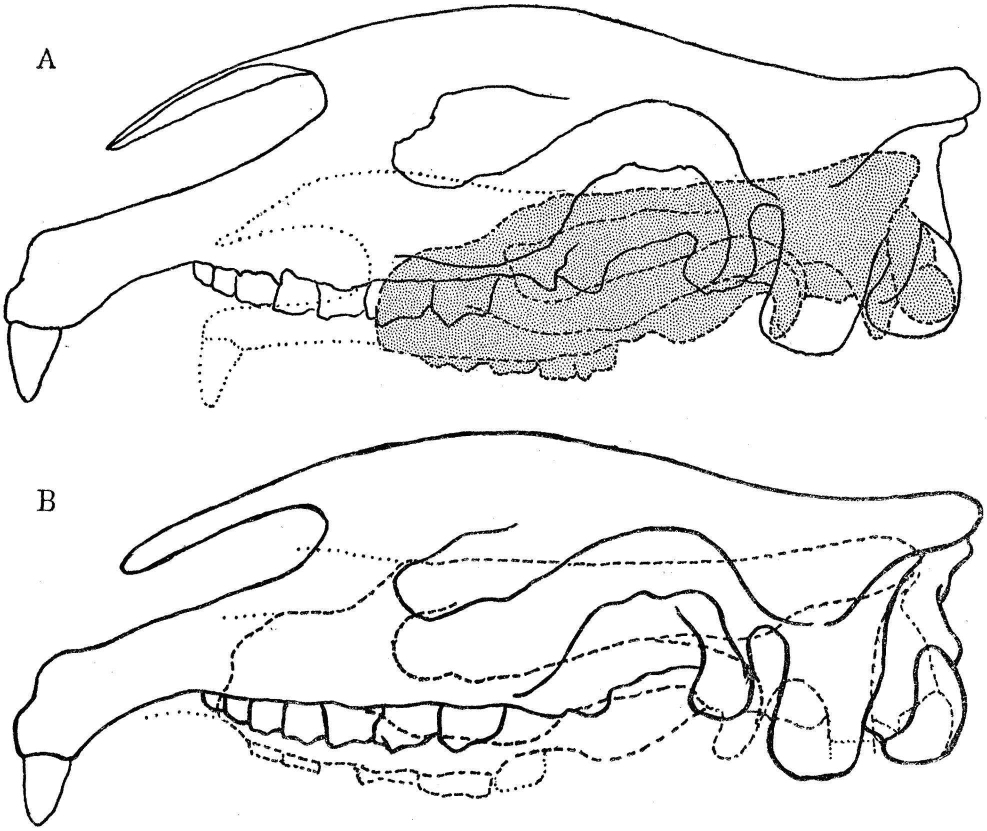

Fig. 19.—Outlines of the skulls of *Paraceratherium bugtiense* - - - - -, and *Baluchitherium grangeri*.——— (A) Reduced to true proportions ; (B) to a common occipital-orbital length.

orbit. To these may be added the difference in the zygomatic arch, which is flat in *Paraceratherium* instead of being arched upwards.

The chief argument against the generic separation of *Baluchitherium* and *Paraceratherium* is the similarity of the tusk formation in the lower jaws. This, though likely, is however a presumption, since the upper tusks of *Paraceratherium* and the lower of *Baluchitherium* are not as yet known. There is also a strong resemblance in the pattern of the upper teeth but, as so many genera of rhinoceroses have similar teeth, too much weight cannot be given to this point.

On the whole, therefore, owing to the many considerable differences it seems permissible to continue to use the generic terms *Paraceratherium* and *Baluchitherium* as a working hypothesis.

Description of a Palate of *Paraceratherium bugtiense* with the Milk Teeth in Position.

Fig. 20, A, and fig. 22, Plate 64.

This specimen, in the condition in which it was originally discovered, consisted of a palate with the anterior part (incisors and as far as the first premolar) broken away, but with the complete set of milk molars in position on each side, with the first molar just in wear and with the second molar just erupting from the alveolus. Behind the second molars and quite close to them the alveolar border closes. Here the posterior border is in perfect condition and extends beyond the teeth for less than a centimetre. It is impossible to believe that any third molar was in process of formation, because in the much smaller skull of a Sumatran rhinoceros, fig. 20, B, also with the milk teeth in place and in practically the same stage of wear, with the first molar in use and the second erupting, the third molar is forming and lies in an alveolus of three and a half centimetres. The specimen must, therefore, be considered as aberrant in the loss of the third molars, and is interesting in this respect in that in another specimen, an adult, of *P. bugtiense* already described (Forster-Cooper, 1924, fig. 5), a somewhat similar condition occurs. In the latter the third molar is absent on each side although the alveolar border is here sufficiently long to have supported the teeth.

The milk teeth have been dissected off on the left side, and underneath are revealed the well-formed premolars. On this side only two teeth, the last two premolars, are present, the anterior teeth having been broken away. On the right side an excavation on the medial side of the first two milk teeth shows the second premolar. Unfortunately the condition of this tooth is poor. It seems to have been twisted round and its position inside the milk teeth, instead of below them, again appears to be abnormal.

The Milk Teeth. Fig. 20, A, and figs. 22, 23, Plate 64.

Of these the first, which, according to divergent views, is to be reckoned either as the first milk tooth or as the first true premolar (Gregory and Cook, 1928), is a triangular tooth with a well-marked parastyle at the anterior end of a long ectoloph. The protoloph is not joined to the ectoloph but, starting near the anterior end, curves right round on the inner side of the tooth to its hind border where it terminates in a well-defined tetartocone. This cusp is joined to the ectoloph by a small low metaloph ridge, so that a valley is formed in the centre of the tooth which is open in front but

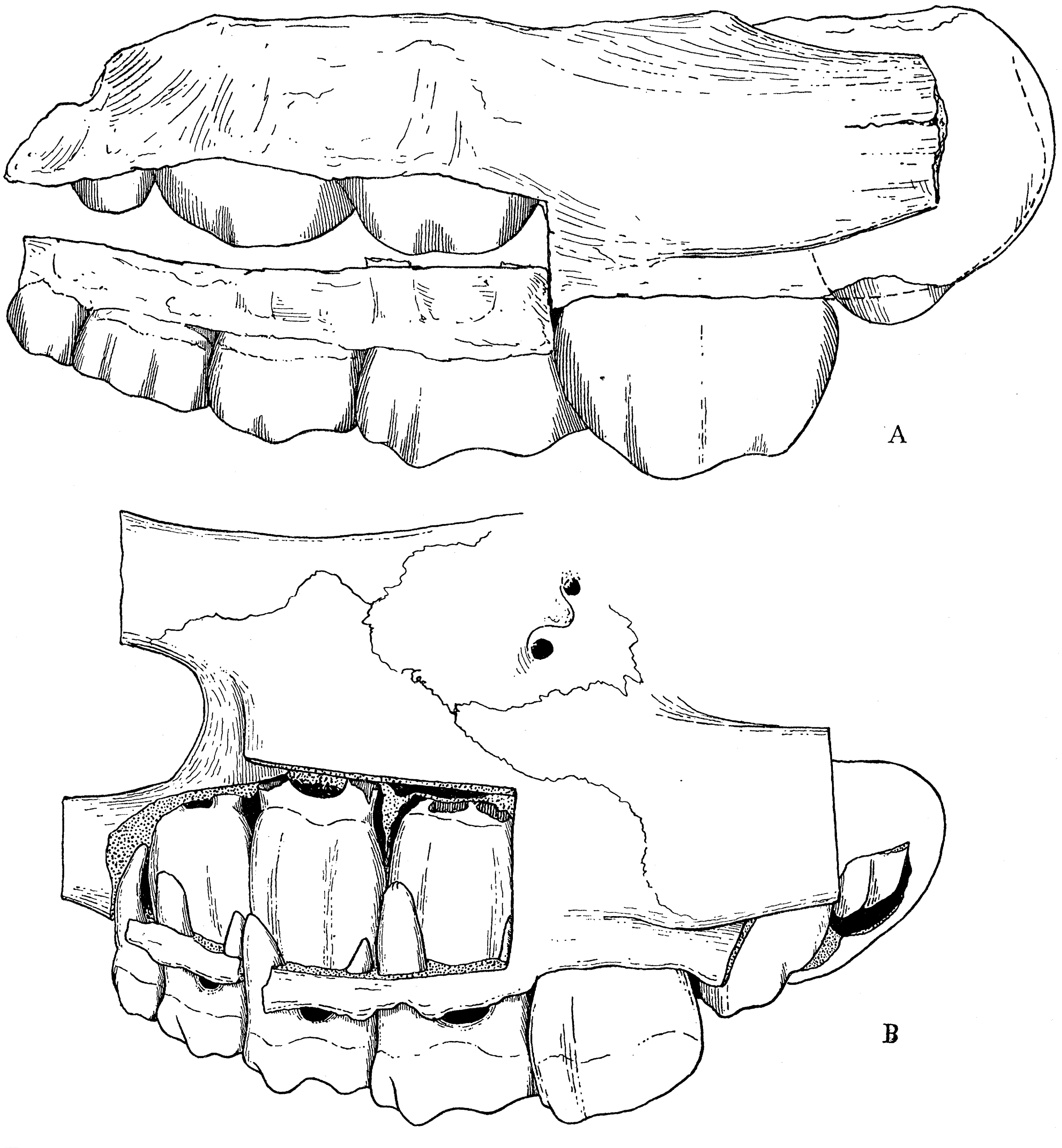

Fig. 20.—*Paraceratherium bugtiense.* (A) Skull in side view showing the milk teeth in position with the first molar erupted and the second molar just cutting the gum. Above are the three permanent premolars dissected out, for comparison with a skull of *R. sumatrensis*, (B) with the teeth in the same stage of growth and dissected out in the same way. Both × ½.

closed on all the other sides by the proto-, ecto- and meta-lophs. The cingulum is only moderately marked on the outside, but is clearly developed on the inner side. Except in the skull of *Baluchitherium grangeri*, where its structure cannot be clearly made out owing to wear, this tooth has not so far been observed in any of the forms discussed. It is clear that in this skull it would have been pushed out at an early stage by the succeeding premolar, and in none of the sets of adult teeth of *Paraceratherium bugtiense* has this tooth been found *in situ*.

Of the following milk teeth the second is still sub-triangular with a protoloph that slopes backwards to a considerable degree. The two remaining teeth are molariform. The cingulum is moderately developed on the outer side of the second, but barely perceptible on the third and fourth teeth. On the inner side it is present and complete in the second, and confined to the front and anterior portions of the third and fourth. The general pattern of these teeth is sufficiently shown by the figures, Plate 64.

A second specimen of a milk dentition of the same species may be mentioned. This is a much younger animal with the first milk tooth only just erupting, the second and third erupted but quite unworn, and the fourth coming up out of its socket. This specimen agrees closely with the one described above, but its perfect and unworn condition shows certain further details, such as the fact that the proto- and meta-lophs join the ectolophs low down and do not reach the top of the external crest as they do in the permanent teeth, fig. 23, Plate 64.

These two specimens show accurately the order of eruption of the teeth, which takes place as follows :—

The second and third milk teeth are the first to appear and are followed by the fourth, which erupts a little ahead of the first. By the time that all four milk teeth are in wear, the second and third being more worn than the first and fourth, the first molar appears, followed in due course by the other molars. From another specimen (Forster-Cooper, 1924, fig. 13) it is clear that the fourth premolar is the first of that series to erupt, followed by the third.

This order of eruption is fairly similar to that found by Gregory and Cook (*loc. cit.*) for *Trigonias*, except that the order for the first and fourth milk molars seems to be reversed.

The Premolars.

As has already been mentioned only two teeth, the third and fourth premolars, occur on the left side, the anterior region having been destroyed. The second premolar is uncovered on the opposite side and is much damaged, but as far as its structure can be made out it appears to have had the same pattern as that already described for *P. bugtiense*. The third premolar has the proto- and meta-lophs distinct from one another to a point below the cingulum. The protoloph slopes a little backwards, is shorter than the metaloph, and joins the ectoloph high up, from which point there is a well-marked parastyle directed forwards and outwards. The metaloph runs at right angles to the ectoloph, and forms a somewhat irregular crest; it joins the well defined tetartocone high up; and then runs downwards to join the ectoloph low down, just in front of a small costal ridge which juts out from the upper part of the ectoloph.

The fourth premolar is less molarized. The protoloph is much like that of the preceding tooth, but the deuterocone joins the tetartocone of the metaloph, the division between these two cusps being marked only by a very shallow groove and a small nick at the top of the two cusps. The metaloph is like that of the third premolar, with the same irregular crest and costa, but it runs a little more forwards, so that the tooth is more triangular than the preceding one. The parastyle is less marked. Molarization, therefore, is proceeding from in front in a backwards direction.

Although the cingulum is damaged, enough remains on both these teeth to show that it was very strong on the front and inner borders, but absent on the posterior inner border. The metastyle in both teeth is well marked.

The structure of the first molar is sufficiently shown by the figures, but attention may be called to the small crochet which is present high up on the anterior side of the metaloph. This dies away, and in a worn tooth might easily escape observation. The second molar, just erupting, shows this same feature. The protocone is flattened on its inner surface, and shows a faint vertical groove which is more marked at the base than at the top.

Now that the milk teeth are definitely known for *Paraceratherium*, a correction must be made with regard to some specimens previously described (Forster-Cooper, 1915) as being the milk teeth of this form. These are not milk teeth, and are described below as belonging to a new and different species.

Paraceratherium (?) *churlandensis* n. sp. Fig. 21.

The type specimens of this species are fragments of the anterior parts of the upper and lower jaws of a young individual, were originally described as the milk teeth of *Paraceratherium bugtiense* (Forster-Cooper, 1924). Apart from the fact that the milk dentition of this species is now fully known, the specimens appear not to be milk, but permanent, teeth. The anterior tooth in the lower jaw, although fully out of the gum, is absolutely untouched by wear, and is therefore unlikely to be the first premolar, fig. 21, A. There is a small depressed area just in front of the leading tooth which may have held the first premolar, but no trace of sockets is visible, and whether or not this tooth was ever present is doubtful. The two teeth must be considered as the second and third premolars, and their chief peculiarity is the great hypsodonty and, as compared with those of *P. bugtiense*, the total absence of an external cingulum. The two upper fragments must likewise be regarded as showing the second and third premolars. They are of opposite sides, and although there is a small difference in pattern between the two (Forster-Cooper, 1924, fig. 17) they must, with the lower jaw fragment, be regarded as belonging to one individual. The three pieces were found close together in the same bone bed at Churlando, from which came the specimens described as *Paraceratherium bugtiense* and *Baluchitherium osborni*.

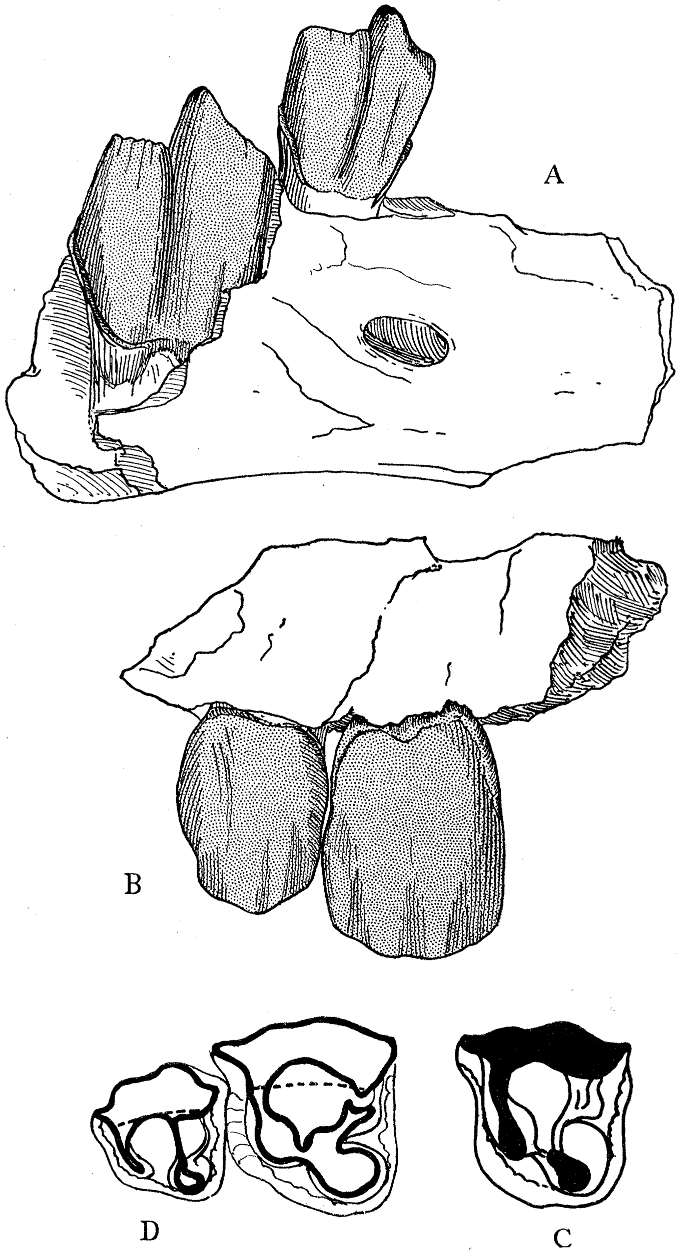

FIG. 21.—*Paraceratherium* (?) *churlandensis* n. sp. $\times \frac{1}{2}$. (A) Anterior portion of the lower jaw, external face; (B) anterior portion of the left maxilla; (C) plan of the third upper premolar crown. The black portion represents the area of wear obtained by grinding down a cast; (D) Plan of the two premolars showing the area of wear on further grinding. The dotted line shows the position of the ectoloph as shown by the original specimen in its unworn condition.

The teeth are unlike any others in the collection, but in some respects seem more nearly to approach those of *Paraceratherium* than any other form. They differ, however, in many features such as the strong inward curvature of the top of the ectoloph in the unworn state, fig. 21, D, in the much greater hypsodonty, and in the heavy cingulum which is complete round the front, inner, and hind, borders, and present externally although lightly marked.

Until further and more complete material is available the generic attribution is entirely tentative.

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The specimens detailed in the present paper have been added to the collections of the British Museum, where the rest of the material collected on the two expeditions has already been placed.

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EXPLANATION OF PLATES.

PLATE 64.

FIG. 22.—Palate of *Paraceratherium bugtiense* showing the milk teeth and permanent premolars. × ½.

FIG. 23.—View of the inner side of the milk teeth of a younger specimen of *P. bugtiense.* Natural size.

FIG. 24.—Second and third upper premolars of a specimen doubtfully referred to *A. albigense.* Natural size.

PLATE 65.

FIG. 25.—*Aceratherium abeli* n. sp. Palatal surface of skull. × ½.

FIG. 26.—First two upper molars and part of the third erupting of a specimen referred to *C. tagicus.* Natural size.

FIG. 27.—A worn third upper molar
FIG. 28.—Upper milk teeth
FIG. 29.—A partially worn third upper molar
FIG. 30.—A worn upper milk molar
} of the same species. Natural size.

PLATE 66.

FIG. 31.—Outer surface of the lower jaw of *Aceratherium abeli.* × ½.

FIG. 32.—Inner surface. × ½.

FIG. 33.—Crown surface. × ½.

PLATE 67.

FIG. 34.—*R. blandfordi* view of the palate. × ½.

FIG. 35.—Two upper premolars of a specimen *incertæ sedis* differing from *R. blandfordi* in the crenelation of the metaloph. Natural size.

FIG. 36.—A premolar of a similar form showing the crochet and crista joined. Natural size.

FIG. 37.—Upper milk teeth and (38) the third premolar in its alveolus of a specimen referred to “*Diceratherium*” *shahbazi.* Natural size.

FIG. 39.—A milk dentition of a species *incertæ sedis* with the third and fourth premolars developed from their alveoli and (40) the partially formed premolars developed from their alveoli.

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