

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SIWALIK RHINOCEROTIDÆ.

By R. LYDEKKER, B.A., F.Z.S.,

GEOLOGICAL SURVEY OF INDIA.

[WITH PLATES I TO X.]

Order: UNGULATA, Div. PERISSODACTYLA,

Family: *RHINOCEROTIDÆ*.

Introductory.—Although in the first volume of this series of the “Palæontologia Indica,” a considerable number of teeth and other remains of various species of rhinoceros, from the tertiaries and post-tertiaries of India and Burma, have been described and figured by Mr. Foote and myself, yet in many cases those remains by no means fully illustrated the dentition and full affinities of the various species, while, from their incompleteness and isolated character, they have in not a few instances led to erroneous inferences. The comparatively recent acquisition of a much larger series of fossil remains of this family by the Indian Museum from Siwalik strata has now enabled me to give a much fuller account of the dentition of most of the Siwalik species, and to correct such previous determinations as subsequently-acquired information has shown to be erroneous. No additional remains of the pleistocene species have been acquired, and it will, therefore, be unnecessary to refer to them at length in this memoir.

Number of species of Siwalik rhinoceroses.—In the “Fauna Antiqua Sivalensis,” three species of fossil Indian true rhinoceroses, from the plio-miocene or Siwaliks of India, were named, upon the evidence of a fairly complete series of remains; while a fourth species, named on very fragmentary remains, was provisionally referred to the genus *Acerotherium*,—a determination which has subsequently turned out to be correct. The above-mentioned four species have been respectively named *R. palæindicus*, *R. platyrhinus*, *R. sivalensis*, and *A. perimense*. In the first volume of the present work two additional species were described from the evidence

of molar teeth under the names of *R. iravadicus* and *R. planidens*; but it will be shown in the course of this memoir that both these so-called species in reality belong to *A. perimense*: in the instance of *R. planidens*, this has already been demonstrated in the preface to the first volume.

General characters of skulls of the four species.—In the preface to the first volume, it has already been shown what are the leading characters of the skulls and dentition of the three Siwalik species of the genus *Rhinoceros*,¹ and also how these species differ from the living Asiatic forms of the genus, with which there has lately been an attempt to unite them: it will not be necessary, therefore, on this occasion to recapitulate the statements there made. In order, however, to show the general form of the skulls of all the Siwalik fossil species of the family, I have caused to be drawn on a small scale (plates IX and X) restored outlines of their skulls, taken either from original specimens in the Indian Museum, or from casts of those in the British Museum, or from those figured in the “Fauna Antiqua Sivalensis.” For the purpose of comparison with these fossil skulls, there are also given outlines of the skulls of the three best determined living species of Asiatic rhinoceroses. The living and fossil Asiatic rhinoceroses, of which the skulls are known,² may be divided for our present purpose into three groups, *viz.*, hornless rhinoceroses, unicorn rhinoceroses, and bicorn rhinoceroses, the figured specimens of which will now shortly be noticed in the above order.

Hornless rhinoceros (Acerotherium).—The only Siwalik species of hornless rhinoceros, referred here to the genus *Acerotherium*, is *A. perimense*, of which the restored skull is drawn in figure 1 of plate IX. The form of this skull distinguishes it at once from the skulls of all the other Indian species of the family. The molars, as will be shown below, are of a simple type, approaching those of the Sumatran and Javan rhinoceroses.

Unicorn rhinoceroses.—Of the unicorn rhinoceroses, solely composing the genus *Rhinoceros*³ as restricted by many modern writers, there are four well-determined recent and fossil Asiatic species of which the skulls are known; these are figured on plate X. Fig. 1 is *R. indicus*; 2, *R. javanicus (sondaicus)*; 3, *R. palæindicus*; and 4, *R. sivalensis*. Apart from the differences in the general outline of the skull, *R. indicus* is distinguished from all by the complex pattern of its upper molars, which have a large ‘combing-plate’ and three ‘fossettes’ when worn. *R. palæindicus* and *R. sivalensis* are distinguished readily by the form of their upper molars, as is noticed in the preceding volume and in the sequel. *R. palæindicus* differs equally in this respect from *R. javanicus*. *R. sivalensis* and *R. javanicus*

¹ This generic term is used in the original wide sense given it by Linné. The modern sub-divisions are frequently inapplicable in the case of fossils.

² The skull of *R. deccanensis* (Foote) is unknown; judging, however, from the form of the lower jaw, it is probable that this was a bicorn species.

³ Apparently by an oversight, Professor Cope includes the bicorn *R. platyrhinus* in his list of the restricted genus *Rhinoceros* (“Bul. U. S. Geol. Geog. Surv.” Vol. V, p. 229). This may have originated from a statement by Professor Flower (P. Z. S., 1876, p. 457) that all the Siwalik species of *Rhinoceros* were unicorn.

seem to be, on the whole, the most nearly allied, since their teeth are constructed on the same general plan; there is, however, considerable difference in the form of the skulls of the two species.

Bicorn rhinoceroses.—Of the bicorn rhinoceroses, there are figured the skulls of two species¹ on plate IX, viz., *R. platyrhinus*, fig. 2; and *R. sumatrensis*, fig. 3. The former has molars of the complex type of *R. indicus*; and the latter of the simpler type of *R. sivalensis* and *R. javanicus*. The latter belongs to the sub-genus *Ceratorhinus*, and the former possibly to a modification of *Atelodus*.

Value of teeth as indicating affinity.—From the above remarks, it will be seen that in species having the same number of horns, and closely allied in other respects,² there may be very great differences in the form of the upper molars; and it, therefore, seems that the structure of these teeth cannot be considered of much value in the determination of the affinities of fossil species.

Number of species of Rhinoceros and Acerotherium.—In order to avoid the necessity of quoting species of *Rhinoceros* and *Acerotherium* by more than one name, owing to the great amount of synonymy that prevails in these genera, the following lists of species with the synonyms has been compiled. The names therein used as the names of the species will be employed in this volume, irrespective of the question whether they all are selected according to strict priority. Doubtful or insufficiently-determined species have prefixed to them a note of interrogation. The memoirs of Messrs. Brandt, Cope, Dawkins, Falconer, Flower, and Peters have been chiefly consulted in the compilation of this list.

GENUS I: ACEROTHERIUM, Kaup.

(Including APHELOPS, Cope.)

1. ACEROTHERIUM CRASSUM (Leidy. sp.). Miocene (?); N. America.
Aphelops (?) *crassus*, Cope.
Rhinoceros crassus, Leidy.
2. ACEROTHERIUM CROIZETI (Pomel). Miocene; Europe.
3. ACEROTHERIUM FOSSIGER (Cope, sp.). Up. miocene; N. America.
Aphelops fossiger, Cope.
4. ACEROTHERIUM GOLDFUSSI (Kaup). Mid. miocene; Europe.
Rhinoceros brachypus, Lart. (*teste* Kaup).
,, *goldfussi*, Kaup.
5. ACEROTHERIUM LEMANENSE (Pomel. sp.). Low. miocene; Europe.
Acerotherium lemanense, Dawkins.
Rhinoceros lemanensis, Filhol.

¹ There is no specimen of the skull of *R. lasiotis* (Sel.) available, if indeed this species be distinct from *R. sumatrensis*.

² See Flower, P. Z. S., 1876, p. 443, *et seq.*

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6. ACEROTHERIUM INCISIVUM (Kaup). Up. eocene and miocene; Europe.

Acerotherium gannatense, Duvernoy (*teste* Kaup).

„ *tetradactylum*,¹ Gaudry.

„ *typus*, Duvernoy.

Rhinoceros incisivus, Cuvier (in part).

„ *tetradactylus*, Lartet (*apud* Filhol. and Laurillard).

7. ACEROTHERIUM JEMEZANUS (Cope). Up. miocene; N. America.

Aphelops (?) *jemezanus*, Cope.

8. ACEROTHERIUM MALACORHINUS (Cope). Up. miocene; N. America.

Aphelops malacorhinus, Cope.

9. ACEROTHERIUM MEGALODUS (Cope). Up. miocene; N. America.

Aphelops megalodus, Cope.

10. ACEROTHERIUM MERIDIANUM (Leidy. sp.). Up. miocene; N. America.

Aphelops (?) *meridianus*, Cope.

Rhinoceros meridianus, Leidy.

11. ACEROTHERIUM (?) MINUTUM (Kaup). Quercy phosphorites, and low. miocene; Europe.

Rhinoceros minutus, Cuvier.

„ *pleuroceros*, Duvernoy (*teste* Brandt).

„ *steiheimensis*, Jäger (*teste* Brandt).

12. ACEROTHERIUM MITE (Cope). Low. miocene; N. America.

13. ACEROTHERIUM OCCIDENTALE (Leidy. sp.). Low. miocene; N. America.

Rhinoceros occidentalis, Leidy.

14. ACEROTHERIUM PACIFICUM (Leidy. sp.). Mid. miocene; N. America.

Rhinoceros pacificus, Leidy.

15. ACEROTHERIUM PERIMENSE (Falc. and Caut.). Mio-pliocene; India and Burma.

Rhinoceros iravadicus, Lydekker.

„ *perimensis*, Falconer and Cautley.

„ *planidens*, Lydekker.

16. ACEROTHERIUM TRUQUIANUM (Cope). Mid. miocene; N. America.

GENUS II: RHINOCEROS (*Linné*).

1.? RHINOCEROS ANNECTANS (Marsh). Miocene; N. America.

2. RHINOCEROS AURELIANENSIS (Noel?). Miocene; Europe.

Ceratorhinus aurelianensis, *apud* Cope.

3.? RHINOCEROS AUSTRIACUS (Peters). Miocene; Europe.

¹ M. Gaudry ("Les Enchainements du Monde Animal, etc.," p. 47) regards *A. tetradactylum* as distinct from *A. incisivum*.

4. RHINOCEROS BICORNIS (Linné). Recent; Africa.
Atelodus bicornis, Pomel.
Rhinaster bicornis, Gray.
 „ *keitloa*, Gray.
Rhinoceros africanus, Cuvier.
 „ *bicornis capensis*, P. Camper
 „ *brucei*, Blainville.
 „ *camperi*, Schinz.
 „ *keitloa*, A. Smith.
 „ *niger*, Schinz.
- 5.?¹ RHINOCEROS CIMOGORRHENSIS (Lartet). Low. miocene; Europe.
- 6.?¹ RHINOCEROS CUCULATUS (Wagner). Recent; Hab. unknown.
Ceratorhinus cuculatus, Brandt.
7. RHINOCEROS DECCANENSIS (Foote). Pleistocene; India.
Atelodus (?) *deccanensis*, Flower.
8. RHINOCEROS ETRUSCUS (Falconer). Up. pliocene; Europe.
Cælodonta etruscus, Cope.
Rhinoceros leptorhinus, Cuvier (in part).
 „ *merki*, Jäger (*teste* Brandt).
9. RHINOCEROS HESPERIUS (Leidy). Miocene (?); N. America.
10. RHINOCEROS INDICUS (Cuvier). Recent and pleistocene; India.
Rhinoceros asiaticus, Blumenbach.
 „ *namadicus*, Lydekker.
 „ *stenocephalus*, Gray.
 „ *unicornis*, Linné.
- 11.?¹ RHINOCEROS INERMIS, Lesson. Recent; Asia.
 ? = *R. javanicus*.
12. RHINOCEROS JAVANICUS (F. Cuvier, Geoffrey, and Gray). Recent and (?) pleistocene;¹ S. E. Asia.
Rhinoceros floweri, Gray.
 „ *javanus*, Cuvier.
 „ *nasalis*, Gray.
 „ *sondaicus*, Cuv. and Horsfield.
- 13.?¹ RHINOCEROS LASIOTIS (Sclater). Recent; S. E. Asia.
Ceratorhinus lasiotis, Garrod.
 ? = *Rhinoceros sumatrensis*.
14. RHINOCEROS LEPTORHINUS (Owen). Pleistocene; Europe.
Atelodus aymardi, Pomel.
 „ *hemitæchus*, Flower.
 „ *merki*, Brandt.

¹ Busk, P. Z. S., 1869, p. 449.

- Cælodonta hemitæchus*, Cope.
Rhinoceros hemitæchus, Falconer.
 ? „ *kirkbergensis*, Jäger.
 „ *merki*, Jäger and Kaup.
 „ *mesotropus*, Aymard, (in part), *teste* Brandt.
 „ *priscus*, Falconer.
 „ *protichorhinus*, Duvernoy, *teste* Brandt.

15. RHINOCEROS MEGARHINUS (Christol.). Pleistocene; Europe.

- ? *Atelodus elatus*, Pomel.
 „ *leptorhinus*, Pomel.
Ceratorhinus monspessulanus, Gray.
Rhinoceros cuvieri, Desmarest.
 ? „ *elatus*, Croizet.
 „ *leptorhinus*, Cuvier.
 ? „ *lunullensis*, Gervais.
 „ *mesotropus*. Aymard, (in part), *teste* Falconer.
 „ *monspessulanus*, Blainville, in part.
 „ *primigenius*, Bronn.

16.? RHINOCEROS NAMADICUS (Falconer and Cautley). Pleistocene; India.

17.? RHINOCEROS OREGONENSIS (Marsh.). Miocene; N. America.

18. RHINOCEROS PACHYGNATHUS (Wagner). Up. miocene; Europe.

- Atelodus pachygnathus*, Flower.
Colodus pachygnathus, Wagner.
Rhinoceros tichorhinus, Duvernoy.

19. RHINOCEROS PALÆINDICUS (Falconer and Cautley). Plio-miocene; India.

- Rhinoceros unicornis*, Brandt.

20. RHINOCEROS PLATYRHINUS (Falconer and Cautley). Plio-miocene; India.

- Ceratorhinus sumatrensis*, Brandt.

21. RHINOCEROS RANDANENSIS. (?) Miocene; Europe.

22.? RHINOCEROS SANSANIENSIS (Lartet). Mid. miocene; Europe.

- Dihoplus sansaniensis*, Brandt.
 = *Rhinoceros schleiermacheri*, Kaup, *teste* Duvernoy and Gaudry.

23. RHINOCEROS SCHLEIERMACHERI (Kaup). Miocene; Europe.

- Ceratorhinus schleiermacheri*, Cope.
Dihoplus schleiermacheri, Cope.
Rhinoceros incisivus, Cuvier, in part.
 „ *leptodon*, Kaup.
 „ *sansaniensis*, Lartet, *apud* Duvernoy.

24.? RHINOCEROS SIMORRENSIS (Lartet). Miocene; Europe.

25. RHINOCEROS SIMUS, (Burchell.) Recent; Africa.

- Atelodus simus*, Pomel.
Ceratotherium oswelli, Gray.
 „ *simum*, Gray.

Rhinoceros camus, H. Smith.

„ *oswelli*, Gray.

26.? RHINOCEROS SINENSIS (Owen). Pliocene (?); China.

27. RHINOCEROS SIVALENSIS (Falc. and Caut.). Plio-miocene; India.

Rhinoceros indicus fossilis, Baker and Durand.

„ *unicornis*, Brandt.

Zalabis sivalensis, Cope.

? *Rhinoceros angustirictus*, Falc. and Caut.

28. RHINOCEROS SUMATRENSIS (Cuvier). Recent; S. E. Asia.

Ceratorhinus blythi, Gray.

„ *crossi*, Gray.

„ *niger*, Gray.

„ *sumatranus*, Cope.

„ *sumatrensis*, Gray.

Rhinoceros crossi, Gray.

„ *sumatranus*, Raffles.

29. RHINOCEROS TICHORHINUS (Cuvier and Fischer). Up. pleistocene; Europe.

Atelodus antiquitatis, Brandt.

„ *tichorhinus*, Pomel.

Cælodonta antiquitatis, Cope.

„ *pallasi*, Gray.

Rhinoceros antiquitatis, Blumenbach.

„ *jourdani*, Lartet and Chantre: *teste* Brandt.

„ *lenensis*, Pallas.

„ *mesotropus*, Aymard, in part, *teste* Falconer.

„ *primigenius*, Bronn.

Dentition of the Rhinocerotidæ.—It will be unnecessary on this occasion to enter at length into the consideration of the dental system of the *Rhinocerotidæ*, of which only the two genera, *Rhinoceros* and *Acerotherium*, need be mentioned at all. The main features of the number and general characters of the teeth of these genera will be found given in the “Odontography” of Professor Owen; while certain points in relation to the homology of some of the teeth will be found mentioned in a paper by the author.¹

It will suffice on this occasion to state that in the upper jaw the rhinoceroses above alluded to may, in the permanent dentition, have either one or two pairs of incisors, or may be destitute of any; while there are never any canines. The permanent upper molar series consists of seven teeth, of which the three last are true molars; while of the anterior four, the first may be a milk-molar and the other three premolars, or all four may be premolars. Four milk-molars are always developed.

In the lower jaw there may be no permanent teeth in advance of the premolars, or there may be either one or two pairs of such teeth, in which case the central pair

¹ Jour. As. Soc., Bengal, Vol. XLIX, pt. II, p. 135.

are invariably small and the outer large. The central pair are certainly incisors, and the outer pair also were formerly universally considered as such; there are, however, strong reasons for considering that the latter may really be canines. For the sake of convenience, however, in this volume they will continue to be referred to as incisors, with this proviso. The lower molar series always consists of seven teeth, of which the first four are generally classed as premolars; it is, however, quite possible that the first of these teeth, as in the upper jaw, is in reality a persistent milk-molar. Four milk-molars are developed.

The variations in the permanent dentition of *Rhinoceros* and *Acerotherium* may be expressed by the following general formula:—

$$I. \frac{(0-2) - (0-2)}{(0-2) - (0-2)} C. \frac{0-0}{0-0} MM. \frac{(0-1) - (0-1)}{(0-1?) - (0-1?)} PM. \frac{(3-4) - (3-4)}{(3?-4) - (3?-4)} M. \frac{3-3}{3-3}$$

In describing the teeth of the various species in the sequel, the most anterior of the permanent molar series will usually be referred to as a premolar, irrespective of the question of its true homology.

With regard to the structure of the upper molar teeth, the following terms are applied to the component parts in this memoir. The teeth are supposed to be viewed from the masticating and internal aspects, as in the accompanying figures:—

Anterior collis = large antero-internal column.

Posterior collis = large postero-internal column.

Median valley = hollow dividing the two 'colles.'

Anterior valley = hollow in front of 'anterior collis.'

Posterior valley = hollow behind 'posterior collis.'

Crochet = process projecting from the 'posterior collis' into the 'median valley.'

Combing-plate = process projecting from the outer wall of the tooth into the same.

Ante-crochet = projection on the posterior side of the 'anterior collis.'

Dorsum = outer surface of tooth.

Costa = vertical ridge on 'dorsum.'

Pass = entrance into 'median valley.'

Buttress = projection at the antero-external angle of the crown.

Accessory fossette = separate pit on the worn crown cut off from the outer extremity of the 'median valley.'

Two different types of upper molars.—The upper molars of most species of *Rhinoceros* and *Acerotherium* easily fall into two main divisions, according to their structure. Those of one type, which may be called the Sumatran type, occur in the living Sumatran and Javan rhinoceroses, and are characterised by the production of the antero-external angle of the crown into a strong 'buttress,' or column, which renders the outer wall of the tooth very sinuous. A characteristic tooth of this type is represented in figure 3 of plate III. No teeth of this type ever present an 'accessory fossette' caused by the union of the 'crochet' and 'combing-plate.' The second type of molar is represented in the large living Indian rhinoceros and in the African rhinoceroses; it is characterised by the absence of the 'buttress,' whence the external wall is approximately straight. Teeth of this type are repre-

sented on plate VIII. Very generally, in this type an 'accessory fossette,' formed in the manner noted above, is present; while a 'crochet' and 'combing-plate' seem to be always present, whether they unite or not. In certain species, as in the Siwalik *R. palæindicus*, the upper molars seem to be intermediate in character between those of the two types mentioned above; these will be occasionally referred to below as the 'intermediate type.'

GENUS I. ACEROTHERIUM, *Kaup.*

(Including APHELOPS, *Cope.*)

The genus *Acerotherium* (with which Professor Cope's genus *Aphelops* is included), established in 1832 by the late Professor Kaup¹ for the reception of a hornless and anteriorly four-toed species of rhinoceros, may be shortly defined as follows:—No horns in either sex; nasals thin and pointed, and their upper surface not differentiated from that of the frontals. Anterior limbs either tri— or tetradactyle; incisors present in both jaws.²

Species: ACEROTHERIUM PERIMENSE, Falconer & Cautley sp.

Synonyms: RHINOCEROS (ACEROTHERIUM?) perimensis, Falc. & Caut.

RHINOCEROS PLANIDENS, Nobis.

RHINOCEROS IRAVADICUS, Nobis.

Earlier notices.—The present species of hornless rhinoceros was first named by Falconer and Cautley on the evidence of some mostly imperfect molars, and a part of a lower jaw obtained from the ossiferous beds of Perim Island, in the gulf of Cambay. These specimens are figured in plate LXXV of the "Fauna Antiqua Sivalensis," and their provisional or hypothetical reference to the genus *Acer-*

¹ "Isis." Dresden, 1832.—The definition of the genus here given is adapted from the one given by the late Professor Brandt (Mem. d. l. Acad. Imp. d. S. Pet., Ser. VII., Vol. XXVI, p. 27). Following Professor Brandt, the genus *Aphelops* of Professor Cope, distinguished from *Acerotherium* by having three in place of four digits on the fore-limb, is here included in *Acerotherium*, as in the majority of cases the number of digits cannot be determined.

² According to Professor Cope ("Bul. U. S. Geol. Geog. Survey," Vol. V, p. 235), the genus *Acerotherium* is characterised by the presence of two pairs of both upper and lower incisors (the outer pair of the latter termed canines) and by the non-union of the post-tympanic and post-glenoidal processes of the squamosal below the external auditory meatus. With regard to the presence of two pairs of upper incisors being characteristic of the genus, it may first of all be observed that two pairs of these teeth are developed in *Rhinoceros schleiermacheri* (Kaup. "Oss. Foss. d. Darmstadt," pl. X, fig. 1), and occasionally in *R. indicus* (Lydekker, J. A. S. B., Vol. XLIX, pt. II, pl. VII, fig. 1); and secondly, that in *Acerotherium incisivum* there appears to be only one pair of upper incisors, as I judge from a cast of a skull in the Indian Museum, and from the figure given by Professor Gaudry ("Les Enchainements du Monde Animal, etc." p. 47, fig. 38)! Again, in the lower jaw of the same species, only the outer pair of incisors (canines) seem to be developed (see Gaudry, *loc. cit.*, p. 51, fig. 46); and only this pair are present in the Indian *A. perimense*. As far as I am able to judge from the cast of the skull of *A. incisivum*, the post-tympanic and post-glenoidal processes appear to be united inferiorly. Professor Cope is therefore, to say the least, unfortunate in the characters he has selected for generic distinction.

therium is only one among many other striking instances of the palæontological acumen of the talented authors of that work. At a later period, some other teeth of a rhinoceros from the same beds in the collection of the Asiatic Society of Bengal,¹ were catalogued by Dr. Falconer under the heading *Rhinoceros*, without the affix of any specific name. Dr. Murchison, however, in the "Palæontological Memoirs"² quotes these specimens as *Rhinoceros perimensis*, apparently on no better grounds than the locality from whence they came. Some (and perhaps all) of the specimens do, however, certainly belong to that species.

At a still later period, some detached teeth of a rhinoceros, belonging to the upper molar series, were described and figured by myself in the first volume of this series,³ under the name of *Acerotherium perimense*. It, however, unfortunately happened that these teeth were wrongly placed in the series, and that some were classed as molars, which were really premolars. Although this error has been corrected in the preface and revised description of the plates of the first volume, it has been partly the cause of other errors, and the foundation of some unnecessary species. In the same volume there were also described and figured two incomplete upper molars of a Siwalik rhinoceros, under the name of *R. planidens*,⁴ on the supposition that they belonged to a new species; while, not long after, some complete upper molars, an upper incisor, and the greater portion of a mandible were noticed in the "Records"⁵ under the same name. After all these notices had appeared, the discovery by Mr. Theobald of a nearly complete cranium of a hornless rhinoceros, together with a separate but more complete specimen of the upper molar dentition, alluded to in the "Records,"⁶ conclusively showed that all the specimens referred to the so-called *R. planidens* in reality belonged to *Acerotherium perimense*, and also confirmed the generic distinctness of this form. These specimens, moreover, showed the error which had been made in the serial determination of the previous specimens described by myself under the latter name. In the preface and reissue of the description of certain of the plates of the first volume of this series, all the above-mentioned errors were corrected.

In the same volume,⁷ two upper molars and the occiput of a rhinoceros from Burma were described and figured under the name of *R. iravadicus*, as they could not then be referred to any of Falconer's species. Now, however, the new specimens have rendered it certain that these specimens likewise belong to *Acerotherium perimense*, though to a small-sized variety. It required the large series of specimens now possessed by the Indian Museum to show that the variations from a common standard occurring in many of these teeth were merely varietal forms. The two specimens of milk-molars figured in figure 4 of plate V of the first volume, and referred in the preface to *R. iravadicus* will also be shown in the sequel to belong, in all probability, to *A. perimense*. In consequence of the above re-determinations,

¹ "Cat. Fos. Rem. Vert., Mus. A. S. B." Calcutta, 1859, p. 195. ² Vol. I, p. 171. ³ P. 51, pl. VI, figs. 2, 5, P. 41, pl. V, figs. 7 and 9. ⁴ Vol. XI, p. 95. ⁵ Vol. XII, p. 47. ⁶ P. 18, pl. V, figs. 1, 2, 3,

the species *R. planidens* and *R. iravadicus* must be removed from the list of Siwalik mammals.

In figure 1 of plate XL of volume II of the second series of the "Transactions of the Geological Society," two teeth of the upper molar series of a rhinoceros were figured, without being specifically named, by the late Mr. Clift. These teeth belong to the present species, as was noticed in the first volume.

This completes the list of previous notices of the species, and I, therefore, now proceed to describe the new specimens forming the subject of the present memoir.

Cranium.—The cranium, of which two views are given on plate I of this volume, was obtained in the year 1878 by Mr. Theobald from the Siwaliks of the Punjab, and is the specimen referred to in the passage of the XIIth volume of the "Records" already quoted. Before proceeding to describe the specimen, it will be well to mention the grounds on which it is identified with *Acerotherium perimense* of Falconer and Cautley.¹ The figured cranium contains a series of seven molar teeth, all much worn down, and thereby showing that the cranium belonged to a fully adult individual. These teeth being so much worn down and partly concealed by closely adhering matrix, are not calculated to afford a satisfactory figure, and accordingly the left upper molar series of a rhinoceros containing precisely similar, though less worn, teeth has been lithographed (pl. II) in order to illustrate the dentition of this species. In the figured series of molars, if the second tooth from the left, being the second premolar, be compared with the perfect upper premolar of *Acerotherium perimense* figured by Falconer and Cautley,² the two will be found to be identical in general characters, the only difference being that the 'cingulum' is crenulated in the one specimen and simple in the other; this, however, will subsequently be shown to be a variable character. On the similarity of these two teeth depends the identification of all the specimens treated of in this volume with *Acerotherium perimense* of Falconer and Cautley. This identification also fixes the serial position of Falconer's specimen, which had hitherto been uncertain. Dismissing for a time the dentition, we may revert to the consideration and description of the cranium. The specimen is more perfect than is usually the case with the larger Siwalik fossils, but has still sustained considerable injuries. It lacks the extremity of the nasals and of the maxillæ; while the premaxillæ are, of course, likewise wanting. Both zygomæ have been broken away near their origin, and the processes of the squamosal region of the lower aspect have also disappeared. The teeth are a good deal battered, and the ridges bounding the temporal fossæ have also suffered. Pressure has, moreover, somewhat interfered with the original symmetry of the skull, as is shown in figure 2. As before said, the teeth indicate that the cranium belonged to an aged animal—an inference confirmed by the total obliteration of all the cranial sutures.

¹ Here and subsequently I allude to the species as an *Acerotherium*.

² F. A. S., pl. LXXV, fig. 15. In the description of this plate the number of this specimen is given wrongly as fig. 14.

If the skull be compared with that of one of any of the living species of rhinoceros, it is firstly remarkable for its gigantic size. The next point that strikes the observer is the great width and flatness of the fronto-parietal region, which forms a nearly smooth triangular surface, with its base below (pl. I, fig. 2). The great width of this surface in the neighbourhood of the occipital crest is especially notable. Some distance behind the orbit, there occurs on this surface a small median oval-shaped elevation, succeeded by a slight depression. It has occurred to me as just possible that this elevation may have carried a rudiment of a posterior horn. The profile is nearly straight as far as the fronto-nasal suture, where there occurs a sharp bend, the planes of the nasals and frontals forming an obtuse angle with each other. The portion of the nasals remaining shows that these bones are transversely arched their sides being situated almost at right angles to their upper surface: when complete they must have been short, straight, and pointed. They are perfectly smooth superiorly, showing no trace of the roughened and longitudinally-arched form so characteristic of the living forms of rhinoceros. The form and condition of these bones also shows that the animal had no trace of any anterior horn, and the species is accordingly referred to the genus *Acerotherium*, as defined above. The orbit is of great size, and the vertical thickness of the skull in the region of the orbit is also a noticeable point. There do not appear to be any other points calling for especial notice in the general form of the skull. From the obliteration of the sutures and the somewhat battered condition of the specimen, the relations of the component bones cannot be determined: this renders it impossible to say whether the bones surrounding the external auditory meatus corresponded to the type of *R. indicus* and *R. javanicus*, or to that of *R. sumatrensis* and the African rhinoceroses.

Dimensions of cranium.—In the following table, the dimensions of the figured cranium are given in the first column, while in the second are given such of the corresponding dimensions of the original skull of the European *Acerotherium incisivum* as occur in Kaup's description;¹ the original dimensions were given by Kaup in millimetres, but have here been converted into inches and tenths for convenience of comparison:—

Length from occiput to tip of nasals	19·0 (broken)	19·6
Height of occiput from base of foramen magnum to crest	10·0	8·6
Greatest width of occiput	12·0	
Breadth at postorbital process of frontals	10·5	6·8
Interval between anterior angle of orbit and auditory fissure	13·2	9·5
" " " extremities of zygomæ	12·5	
Vertical diameter of orbit	3·7	
Breadth of base of nasals	4·0	
Length of seven molars	14·6	10·0
Interval between inner surfaces of the first of the molar series	3·0	3·3
" " " " " last " " "	4·4	3·3
Long diameter of occipital condyle	3·2	

¹ "Ossements Fossiles d. Mus. d. Darmstadt," pt. III, p. 36. Darmstadt, 1834.

Comparison with A. incisivum.—From the foregoing table of measurements it will be apparent that the cranium of *A. perimense* is of considerably larger size than that of *A. incisivum*, and that the two crania differ in the relative inclination of the molar series. For the purpose of making a better comparison with Kaup's figure of the skull of the latter species,¹ a reduced and restored figure of the skull of the Indian species is given in figure 1 of plate IX. On comparing these two figures, it will be observed that there is a very considerable difference in the profiles of the two skulls. The nasals of the Indian specimen are much thicker at the base, and, as far as can be inferred from the portion remaining, shorter and more wedge-shaped laterally, than those of the European form. The orbit in the former is more closely approximated to the median plane of the frontals than in the latter, and there is consequently a greater depth from the dental border of the orbit to the teeth. The temporal fossa is wider and shorter in the Indian than in the European form, in consequence of which the distance from the anterior border of the orbit to the occipital crest is proportionately greater in the latter. Other minor differences might be indicated, but the above-mentioned, taken together with the great difference in the form of the teeth, which will be subsequently described, show that the two forms are markedly distinct.

Other European species.—There is still considerable doubt how many species of fossil European rhinoceroses should be referred to the genus *Acerotherium*. The late Professor J. F. Brandt, in his synopsis of the living and fossil species of rhinoceroses and their allies,² only admits two European species, in addition to *A. incisivum*, which are provisionally referred to the same genus. Of one of these,—*A. goldfussi*,—the cranium is, I believe, still unknown; while of the other, *A. minutum*, the cranium has been figured by Kaup,³ and, under the name of *Rhinoceros pleuroceros*, by Duvernoy.⁴ The latter figure shows that the skull is of much smaller size than our Indian specimen, and that the nasals are much longer, more highly arched, and not impossibly bore a very minute anterior horn. There appears to be some doubt whether *Rhinoceros aurelianensis* (Nouel?) of the European miocene should not be referred to *Acerotherium*: Professor Gaudry,⁵ however, thinks it was probably furnished with a small horn.⁶ The nasals are more developed, and the profile of the skull less concave than in *A. perimense*. According to M. H. Filhol,⁷ *Acerotherium* (*Rhinoceros*) *lemanense* and *A. croizeti* are characterised by a peculiarity in the molars, which will be alluded to below: the latter is further distinguished from the present species by its greatly inferior dimensions.

¹ *Loc. cit.*, pl. X, fig 2. ² "Mem. d. l'Acad. Imp. d. Sci. d. S. Pet.," Ser. 7, Vol. XXVI, pt. IV.

³ "Beitrag zur näher Kennt. d. urwelt. Säuget.," 1854, pt. 1, pl. VIII.

⁴ "Arch. d. Mus. d'Hist. Nat.," Vol. VII, pl. I, fig. 2a.

⁵ "Les Enchainements du Monde Animal, etc." p. 18, fig. 39.

⁶ Professor Cope (*loc. cit.*, p. 229) refers this species to the group *Ceratorhinus*: it is very difficult to see on what grounds this determination is made.

⁷ "Ann. d. Sci. Geol.," Vol. XI, pp. 78-79.

American acerotheria.—In the foregoing list of the species of the genus *Acerotherium* (with which is combined the genus *Aphelops* of Professor Cope) there are enumerated ten American species of rhinoceros provisionally referred to that genus, namely, *A. crassum*, *A. fossiger*, *A. jemezianus*, *A. malacorhinus*, *A. megalodus*, *A. meridianum*, *A. mite*, *A. occidentale*, *A. pacificum* and *A. traquianum*.¹ But few of these American species of acerotheria appear to be represented by complete crania, and any comparison between them and the Indian representative of the genus must consequently be deferred till the upper molars of the latter have been described.

Upper molar dentition.—The fine specimen of the left upper maxilla of a rhinoceros, of which the dentition is represented in plate II, was obtained by Mr. Theobald in the Siwaliks of the Punjab, and is the specimen already alluded to. As noticed above, the molar teeth in this jaw correspond exactly with those of the skull just described; but being less worn, and in a better state of preservation, have been selected for figuring. The specimen exhibits the four teeth of the premolar series, in the last of which the outer wall has been somewhat damaged; and the first, and a considerable portion of the second, true molar. In advance of the first tooth of the molar series, the section of the jaw exhibits the root of an incisor tooth. The second, third, and fourth teeth (counting from the left) are seen to belong to the premolar, and not to the milk-molar series, from the fact of the fourth tooth being less worn than the fifth,—the first true molar.

1st premolar.—The first tooth is of an irregularly triangular shape, and of relatively large size; its crown is considerably more worn down than that of the succeeding tooth, and the whole tooth is more elevated above its alveolus than any of the others. It is, therefore, not improbable that this tooth in reality is the first of the milk-molar series, which has never been replaced by a premolar; it is, however, more convenient to refer to it as the first premolar.²

2nd premolar.—The second premolar has an approximately square-shaped crown: the ‘anterior collis’ is smaller than the posterior, and there is no distinct ‘crochet’ in the ‘median valley.’ A very well-marked sinuous and crenulated ‘cingulum’ surrounds the greater part of three sides of the crown: this ‘cingulum’ on the inner side rises high above the entrance to the ‘median valley.’ The ‘dorsum,’ or external surface of the crown, is nearly flat, but presents a slight tendency to be thrown into vertical folds at its antero-external angle. This tooth corresponds almost exactly to the left upper premolar figured in the “Fauna Antiqua Sivalensis”³ under the name of *Rhinoceros (Acerotherium) perimense*, and, as already

¹ In his last paper on the extinct rhinocerotidæ of America (*loc. cit.*) Professor Cope omits some of the above mentioned species; it is, however, not stated on what grounds these omissions are made, and they are accordingly all mentioned in this work. As well-established species like *R. deccanensis* and *A. perimense* are likewise omitted from the same list, it may be that the other omissions are due to want of care, though this seems strange, seeing that several of them were named by the author of the paper in question.

² For the homology and replacement of this tooth, see the above-quoted paper by the author in the “Journal of the Asiatic Society of Bengal,” Vol. XLIX, pt. II, p. 135.

³ Pl. LXXV, fig. 15 (numbered 14 in description of plate).

mentioned, it is on this identification that the specific determination of the cranium and other teeth of this species depends. The tooth figured by Falconer is drawn of half the natural size, and is slightly smaller than our specimen. The former further differs from the latter, in that the 'cingulum' is not distinctly crenulated, and that on the inner side it bends outwards into the entrance of the 'median valley,' in place of passing straight across it. These, however, are trifling differences, and a specimen of the corresponding tooth figured by myself in the preceding volume of this series¹ is intermediate in these respects between the other two homologous teeth, the 'cingulum' being partly crenulated, and extending a short distance into the 'median valley.' In the figure in the previous volume last referred to, two molars are drawn, and these were originally considered to be respectively the last premolar and the first true molar, in place of the second and third premolars. The grounds of this determination were, *firstly*, that the serial position of Falconer's figured premolar was unknown; and, *secondly*, that of my own two figured specimens, the smaller, or anterior tooth, as is stated on page 51 (33) of the first volume, is less worn than the larger and succeeding tooth (right side of figure). In normal cases this would indicate that the smaller tooth was the last premolar, and the larger the first true molar, and accordingly the teeth were so reckoned. The present complete specimen of the dentition has, however, shown that this determination was erroneous, and that consequently the degree of relative wear of the two teeth figured in the first volume must be due to some abnormality in the time of their appearance above the gum. The teeth figured in the first volume being reckoned, respectively, as the last premolar and the first true molar, it was on that supposition totally impossible that the true molars referred in that volume to *R. planidens* could belong to *Acerotherium perimense*, and they were accordingly assigned to a new species.

Another incomplete specimen of a second upper premolar, which has been referred to *Acerotherium perimense*, is drawn in figure 6 of plate VI of volume I. This tooth was originally described as belonging to an unknown species of *Rhinoceros*, and was obtained from the lower Manchhar rocks of Sind. It shows a wavy but uncrenulated cingulum passing entirely across the entrance to the 'median valley,' as in the specimen figured in this volume. It, however, presents a distinct 'crochet,' which is wanting in the other figured specimens, though there seems, judging from other teeth, to be some range of variability in this respect. The determination of this tooth is, therefore, still open to a certain degree of doubt. The first of the two upper molars of a fossil rhinoceros from Burma figured by Mr. Clift,² and already referred to, corresponds in general form with the second upper premolar of *A. perimense*, and is consequently referred to that species;³ the second tooth in Mr. Clift's figure will consequently be the third upper premolar. In the second premolar, as far as can be inferred from the figure, the 'cingulum' is less developed in both teeth

¹ Pl. VI. fig. 5.

² "Trans. Geol. Soc.," 2nd Ser., vol. II., pl. XL., fig. 1.

³ This determination was first made in the first volume of this series (p. 52), but the serial position of the two teeth was incorrectly determined.

than in the specimen figured in this volume, and more resembles the specimen figured in the first volume of this series. From the comparison of the various available specimens of the second upper premolar of the present species, it will be apparent that slight variations in the form of the 'cingulum' of this tooth may occur, which cannot be reckoned as of greater importance than mere individual characters.

3rd premolar.—The penultimate premolar, the third tooth from the left in the figure, is of considerably larger dimensions than either of the preceding, its transverse diameter being greater than the longitudinal. In this tooth, as in all the succeeding ones, the 'anterior collis' is stouter than the posterior. The 'pass' into the 'median valley' is situated at a considerable distance within the mouth of the valley, the latter becoming suddenly very deep behind the 'pass.' When worn down, this tooth, like the succeeding teeth, would present two 'fossettes' on the crown (formed by the outer part of the 'median valley,' and by the 'posterior valley'), and a notch on the inner border (formed by the outer half of the 'median valley'). The 'cingulum' is distinctly crenulated, and occupies the greater portion of three sides of the crown; it is, however, interrupted on the inner surface of the 'posterior collis.' There is no distinct 'crochet,' but there is a rudimentary 'combing-plate.' The 'dorsum' of this tooth is nearly flat, but shows a tendency to the development of a 'buttress' at its antero-external angle. This tooth corresponds very closely with two specimens of the corresponding tooth drawn in figures 2 and 5 of plate VI of the first volume of this work. In the former of those specimens, however, the 'crochet' is more distinctly developed, and the antero-external angle of the crown more bevelled off. Mr. Clift's specimen has been already noticed.

4th premolar.—The last premolar, the fourth tooth from the left in the figure, has much the same general characteristics as the preceding tooth, the main points of difference, irrespective of size, being the greater development of the 'buttress' at the antero-external angle of the crown, and the presence of a distinct 'crochet.'

1st true molar.—The first true molar, the fifth tooth from the left, is distinguished from either of the two preceding teeth by its antero-posterior diameter being greater than the transverse. The antero-external angle of the crown is produced into a well-marked 'buttress,' and the 'dorsal' surface is in consequence considerably sinuated. The 'anterior collis' is of great stoutness, and bears on its anterior surface a vertical groove, while on its posterior surface there is a vertical ridge projecting into the 'median valley,' which may conveniently be termed the 'ante-crochet.' The 'median valley' is wide and spacious, and deepens continually from its entrance, there being no internal 'pass,' as in the premolars: a large and blunt 'crochet' projects obliquely into the 'median valley' from the 'posterior collis.' On the internal face of the tooth, the 'cingulum' is interrupted on the two 'colles,' so as to form three distinct portions,—an anterior, a median, which makes a tubercle at the entrance to the 'median valley,' and a posterior portion. The 'posterior valley' is

large and triangular in shape: the postero-external angle of the tooth is produced into a wedge-shaped process.

Identity with R. planidens.—If this tooth be compared with the two fragmentary upper molars, drawn in figures 7 and 9 of plate IV of the first volume of this work, and upon the evidence of which the new species *R. planidens* was founded, it will be at once apparent that all three teeth belong to the same species.

2nd true molar.—The second true molar in the figured upper dentition is unfortunately so much broken that only its anterior half remains. This portion shows that the tooth had a large antero-external ‘buttress,’ and that the ‘cingulum’ was interrupted on the inner surfaces of the two ‘colles.’ There is a large ‘crochet,’ and the rudiment of a ‘combing-plate,’ which, however, does not extend to the base of the ‘median valley.’ As this tooth is so imperfect, another and complete specimen, also obtained by Mr. Theobald from the Siwaliks of the Punjab, has been drawn in figure 3 of plate III.¹ This tooth agrees very closely in general characters with the second true molar in the previous plate, and is evidently the corresponding tooth of the opposite (right) side of the jaw of the same species. The isolated tooth, however, differs slightly in the form of the ‘cingulum’ from the corresponding tooth in the full series. This difference consists in the fact of the ‘cingulum’ being less distinctly crenulated and more closely applied to the surface of the crown, and also that it forms a continuous, although a thin, line along the internal surface of the ‘anterior collis.’ In respect of the form of the ‘median valley,’ ‘crochet,’ and ‘colles,’ the two teeth are identical.

Identity with R. iravadicus.—If the figure of the above-described second upper true molar of *Acerotherium perimense* (pl. III., fig. 3) be compared with the corresponding tooth of a rhinoceros from Burma, drawn in plate V, fig. 2 of the first volume of this work under the name of *R. iravadicus*, it will be found that in general characters the two teeth are absolutely alike, and they must consequently be referred to the same species. As the last mentioned tooth, together with a corresponding tooth of the opposite side (vol. I., pl. V., fig. 1) were the types on which the species *R. iravadicus* was established, it is evident that this species must be merged in *Acerotherium perimense*. It was impossible, from the materials at hand at the time of publication of the second part of the first volume, to identify the teeth described under the name of *R. iravadicus*, either with those described as *R. planidens*, or with those as *A. perimense*. It has been shown that there is a certain amount of variability in the upper molar teeth of *A. perimense*, and it required a large series of specimens to demonstrate the unity of species of these several varieties. In figure 3 of plate V. of the first volume an imperfect occiput of a rhinoceros from Burma, was also figured under the name of *R. iravadicus*. As far as can be judged from this specimen, it appears to agree very closely in form with the cranium of *A. perimense* described above, and may, therefore, probably be referred to that species.

¹ The specimen was lithographed in my absence, and has unfortunately been placed somewhat out of its proper position.

In figure 4 of the same plate are drawn two upper milk-molars of a rhinoceros, which were also considered in the preface to belong to the same species as the true molars. It will be shown in the sequel that these teeth also may probably be referred to *A. perimense*, so that the name *R. iravadicus* must be withdrawn. As will be seen from an inspection of the figures, the upper molars of *A. perimense* from Burma are of considerably smaller size than those from the Punjab; and, as the same will subsequently be shown to be the case with the milk-molars, it may not be improbable that there existed a smaller Burmese race of the species.

Last upper true molar.—Of the last upper true molar of *Acerotherium perimense*, a specimen from the right side is drawn in figure 5 of plate III. This specimen is one of an associated set of upper molars from Mr. Theobald's Punjab collection. The anterior teeth are in general characters precisely similar to those already figured, and, therefore, need no further mention. The last true molar shows a large 'cingulum' surrounding the 'anterior collis,' the latter being of great size and thickness. A large tubercle, which may be considered as a detached portion of the 'cingulum,' obstructs the entrance to the 'median valley.' The 'posterior collis' is thin, and gives off a distinct 'crochet' projecting into the 'median valley.' The antero-external angle is produced into a strong 'buttress.'

Dimensions of upper molar series.—Having now passed in review the whole of the upper series of molar teeth of this species, we may firstly give the dimensions of the figured specimens, and then proceed to institute comparisons between them and the molars of other species of the genus. The following table gives the dimensions of the five complete anterior teeth drawn in plate II, and of the two later teeth in figures 3 and 5 of plate III:—

Length of first premolar	. . . . .	1.3
Width of „ „	. . . . .	1.15
Length of 2nd „	. . . . .	1.6
Width of „ „	. . . . .	1.9
Length of 3rd „	. . . . .	1.9
Width of „ „	. . . . .	2.8
Length of 4th „	. . . . .	2.2
Width of „ „	. . . . .	3.2
Length of 1st true molar	. . . . .	3.2
Width of „ „	. . . . .	3.2
Length of 2nd „	. . . . .	3.35
Width of „ „	. . . . .	3.3
Length of 3rd „	. . . . .	3.2
Width of „ „	. . . . .	3.2

General characters of upper molars.—The foregoing descriptions, with the accompanying plates, will have shown that the teeth of the upper molar series of *Acerotherium perimense* are formed on the general plan of those of the living Sumatran and Javan rhinoceroses (*R. sumatrensis* and *R. javanicus*).

They are characterised by a 'buttress' at the antero-external angle; by a more or less complete 'cingulum,' which always forms a tubercle at the entrance to the 'median valley'; by the presence of a 'crotchet,' and by the normal absence of a

'combing-plate' and of a third or 'accessory fossette' on the well worn crown. The 'cingulum' is more developed in the premolars than in the true molars; while the reverse of this arrangement prevails with regard to the 'buttress' and the 'crochet.' Although, as already said, agreeing in general plan with those of the Sumatran and Javan rhinoceros, the molars of the Perim species are at once broadly distinguished by the presence of the large 'cingulum.'

Comparisons with molar series of other species of Siwalik rhinoceros.—Although the cranium of the present species at once distinguishes it from the crania of all the other species of Siwalik rhinoceros, it may be well to point out how the teeth may be distinguished, as they are the remains most frequently met with in the fossil condition. Now that the two so-called species, *R. planidens* and *R. iravadicus*, are shown to be identical with the present species, there only remains *R. platyrhinus*, *R. palæindicus*, and *R. sivalensis* for comparison. The upper molars of the first of these species¹ are formed on the type of *R. indicus*,—that is, they have no external buttress, but a 'combing-plate' and 'accessory fossette' on the worn crown, and are, therefore, totally unlike those of the present species. The upper molars of *R. palæindicus*² have a much less developed 'buttress' at the antero-external angle, a larger 'crochet' extending across the 'median valley,' so as not unfrequently to cut off a third or 'accessory fossette' on the much-worn crown: the 'cingulum' and tubercle at the entrance of the 'median valley' so characteristic of the present species, are in general practically absent in *R. palæindicus*. The upper molar series of *R. sivalensis*³ approaches nearer in general plan of structure to that of the Perim hornless rhinoceros; but the teeth are at once distinguished by the absence of any trace of a 'cingulum' on the inner surface, or of any tubercle at the entrance to the 'median valley.' The 'crochet' of the premolars, as will be noticed below, is, moreover, much more developed in *R. sivalensis*.

Resemblance to R. deccanensis.—In describing the second upper premolar subsequently referred to *Acerotherium perimense* from Sind, but which I was then unable to refer to that species, in the first volume of this series,⁴ I commented upon the resemblance which it presented to the premolars of *Rhinoceros deccanensis* of Mr. Foote,⁵ and consequently inferred that the latter species showed indications of affinity with the older forms of the family,—a very noticeable fact in a pleistocene species. The subsequently-acquired specimens have fully borne out the resemblance between the molars of the two forms. If the figures of the upper premolars given by Mr. Foote be compared with those of *A. perimense* given in this volume, it will be apparent that there is a most marked resemblance between them.⁶ The common features are the large 'cingulum,' and the approxi-

¹ Infra, pl. VIII.

² Pl. VI, fig. 1. F. A. S., pl. LXX, fig. 1.

³ Supra, Vol. I, pl. V, fig. 5.

⁴ Pp. 44—5.

⁵ Supra, Vol. I, p. I, *et. seq.*, pl. I.

⁶ In Mr. Foote's specimen the first premolar is wanting, and therefore the first three teeth in that figure correspond to the second, third, and fourth teeth in my figure.

mation of the bases of the two 'colles.' The 'cingulum' in *R. deccanensis* appears to exist as a more distinct ledge than in the Perim acerotheria, and is not crenulated;—the latter character, however, seems to be a variable one. The 'crochet' is strongly developed in the third premolar of the Deccan rhinoceros, and the buttress at the antero-external of both premolars and molars is very slight, in which respect this species differs from the Perim acerotheria. In the dilapidated condition of the molars of the former, a close comparison would be difficult. The two species were, however, in all probability widely different in their anterior teeth; *R. deccanensis* had certainly no incisors in the lower, and probably none in the upper jaw; while *A. perimense* probably possessed these teeth in both jaws.

Comparison with European acerotheria.—It will be unnecessary to institute a comparison between the upper molars of *Acerotherium perimense* and those of fossil European species of *Rhinoceros*, since the difference in the crania affords abundant ground of distinction; the comparisons are, therefore, confined to the genus *Acerotherium*. The molars of *A. incisivum*,¹ apart from their greatly inferior size, are distinguished by the 'cingulum' being much smaller, more closely applied to the tooth, never crenulated, or interrupted, and not forming a large and distinct tubercle at the entrance to the 'median valley.' The premolars are also more equal in size than are those of the Perim species, and there are numerous minor differences in the form of the teeth of the two species, which can be best understood by an inspection of the figures. The most important of these minor differences is the tendency to the formation of a third, or 'accessory fossete,' in the worn premolars of *A. incisivum*, which is totally wanting in *A. perimense*. Of the upper teeth of *A. goldfussi*, the best figure available is that of a molar given by Kaup² This tooth appears to have a less completely developed 'cingulum' than the teeth of *A. perimense* figured here, but agrees in this respect more nearly with this part of the teeth of the latter figured in plate VI., figure 5 of volume I. The small figures of upper molars of *A. goldfussi* given by Kaup³ indicate no tubercle at the entrance of the 'median valley:' and no cingulum in the last true molar. The upper molars of *A. minutum*⁴ and *A. croizeti*,⁵ are sufficiently distinguished from those of the present species by their inferior size, as well as by their possessing no distinct 'cingulum' on their inner surface. The molars of *A. croizeti* and *A. lemanense* are, according to M. Filhol,⁶ distinguished by the absence of the 'crochet.'

Dentition of American acerotheria.—Of the ten species of American rhinoceroses provisionally referred to the genus *Acerotherium* noticed above, the upper true molars of *A. crassum*⁷ have no distinct tubercle at the entrance to the 'median valley.' In *A. fossiger*⁸ there is no 'cingulum' to the true molars.

¹ Kaup. "Oss. Foss. d. Mus. d. Darmstadt," pl. xiv., fig. 5.

² *Loc. cit.*, pl. xii., fig. 12.

³ "Beit. zur näher Kennt. d. urwelt. Säuget.," pt. I, pl. II.

⁴ "Oss. Foss. d. mus d. Darmstadt."

⁵ Filhol. *op. cit.*

⁶ *Op. cit.*

⁷ "Journ. Acad. Nat. Sci. Philad.," 2nd ser., vol. vii., pl. xiii. fig. 8.

⁸ "Bul. U. S. Geol. Geog. Surv.," vol. v., p. 237.

A. jemezianus,¹ was described upon the evidence of the mandible only, and I do not know whether the upper molars have been subsequently discovered. In *A. malacorhinus*² the 'cingulum' extends continuously round the whole of the inner surface of all the premolars, being never interrupted as in *A. perimense*. In *A. megalodus*, as far as I can gather from Professor Cope's description,³ there is no 'crochet' in the upper true molars, and the 'cingulum' is wanting from the 'posterior collis' of the premolars.

The upper molars of *A. meridianum*⁴ present a considerable resemblance to those of the Indian species. As far, however, as I can judge from the figure, they appear to differ by the greater development of the protuberance from the 'anterior collis' into the 'median valley' in the premolars, and also by the simpler form of the 'cingulum.'

*A. mite*⁵ is readily distinguished from the present species by the fact of the 'colles' ('transverse crests' of Prof. Cope) of the premolars being united on the inner side, and by there being no 'cingulum' on the inner surfaces of the true molars.

In *A. occidentale*⁶ the premolars present a very considerable resemblance to those of the present species; the true molars are, however, readily distinguished by the absence of any distinct 'crochet' and by differences in the form of the 'cingulum.' The upper molars of *A. pacificum*⁷ are characterised by a small and continuous 'cingulum,' and by the absence of a 'crochet,' and 'buttress' at the antero-external angle. Of *A. truquianum* I have been unable to discover a description of the upper molars.

General characters of upper molars.—It has now been shown that, as far as the materials for comparison are available, the Perim Island acerotheres seem to be a distinct species, and consequently, in treating of the other remains referred to that species, it will be unnecessary to institute comparisons between them and those of other species. In the upper molar dentition of *A. perimense*, the most noticeable general points are that the whole dentition is generally less specialised than that of *Rhinoceros*. This want of specialisation is shown in the general completeness and great development of the 'cingulum,' which is more marked in the premolars than in the true molars,⁸ and is a character connecting the genus with the generalised

¹ "Proceedings Acad. Nat. Sci. Philad.," 1875, p. 260.

² "U. S. Geol. Geog. Surv.," vol. v., p. 237.

³ "U. S. Geol. Geog. Surv. of Colorado," 1873, p. 52.

⁴ "U. S. Geol. Surv. W. of 100th Merid.," vol. iv., pl. lxxiii., fig. I.

⁵ "U. S. Geol. Geog. Surv. of Colorado," 1873, p. 494.

⁶ "Jour. Acad. Nat. Sci. Phil.," 2 Ser., Vol. VII., pl. xxii. (*Rhinoceros occidentalis*).

⁷ Leidy. "Contrib. to Ext. Vert. Fauna of West. Territories." U. S. Geol. Surv., pl. II., fig. 6, 7 (*Rhinoceros pacificus*).

⁸ On page 15 of the first volume of this series it is stated by Mr. Foote that "in *R. perimensis*, Falconer, the guard (cingulum) is absent from the upper premolars." It is difficult to see how this statement originated, since the only complete tooth figured by Falconer was a premolar with a most marked 'cingulum.' The premolars of *R. deccanensis* in respect of the presence of a large 'cingulum,' approach very closely to those of *A. perimense*; the true molars of the latter have, however, a 'buttress,' which is wanting in the former.

tapiroid and palæotheroid types, such as *Hyracodon*, *Palæotherium*, etc. The same want is shown in the absence of the 'crochet' in the earlier premolars. The absence of any distinct 'combing-plate' indicates affinity with the species of rhinoceros having a molar dentition constructed on the type of that of the Sumatran rhinoceros, a less complex type than that occurring in the tichorhine and Indian rhinoceroses.

Palate from Perim Island.—Since the above descriptions were written, another specimen of the upper dentition of this species has come under the author's notice. The specimen belongs to the museum of the Bombay Branch of the Royal Asiatic Society, and has been already alluded to in another publication of the Survey.¹ It was obtained from the Siwaliks of Perim Island in the gulf of Cambay. By the courtesy of the Council of the above mentioned Society, the specimen has been temporarily lent to the Indian Museum, with permission to describe and figure; and accordingly a figure of the molar dentition of the right side has been intercalated among the plates accompanying this memoir (pl. II A.).

The specimen, which bears numerous recent bivalves on its surface testifying to its place of origin, comprises the greater portion of the palate, exhibiting on the right side all the molar series, with the exception of the first tooth; and on the left, the three true molars only. The molar series of the right side, being the more complete, has been selected for illustration. In the figured series, the first true molar has been considerably damaged, but the remaining five teeth are in a fair state of preservation. A comparison of the additional plate with plate II will at once show that the two series of teeth belong to the same species. The Perim specimen is, however, important from the fact that in all the teeth the 'cingulum' is much less developed than in the Punjab specimen. A similar variation has already been noticed in the case of isolated teeth of the species. The Perim specimen is further important, in that it shows the complete last true molar, but slightly worn,—a tooth lacking in the Punjab specimen.

The dimensions of the Perim specimen are as follows:—

Width of palate between last true molars	5·2
" " 1st "	4·32
Length of three true molars	7·8
" of molar series (five teeth)	13·2
" of 2nd premolar	2·05
Width of " "	2·09
" of 3rd "	2·8
Length of 4th "	2·2
Width of " "	3·3
Length of 1st true molar	3·1
Width of " "	3·4
Length of 2nd "	3·1
Width of " "	3·4
Length of 3rd "	2·09
Width of " "	3·2

¹ R. G. S. I., Vol. XIV., p. 156.

Upper milk-molars.—In figure 2 of plate III of this volume are drawn two upper molars of a rhinoceros, collected by Mr. Theobald in the Siwaliks, near the village of Asnot, in the Punjab. These teeth are implanted in a fragment of the left maxilla, which also shows the bases of the crowns of other teeth on either side of the two now remaining. Below the broken crown of the tooth on the right side of the figure, there is seen in the jaw the germ of another tooth, which would have replaced vertically the tooth above it. The presence of this germ-tooth in the jaw proves that the tooth above it, and all the teeth in advance of it, must belong to the milk-molar series; consequently, the two figured teeth, as they are in advance of the tooth above the germ, and as they again had another tooth in advance of them, must be the second and third upper milk-molars of a rhinoceros, and it now only remains to consider to what species they belong. Of the three species of Siwalik rhinoceros besides the present, the milk-molars of *R. palæindicus* are known with tolerable certainty, and will be noticed below. Milk-molars of two other types are also known, and, as will be seen below, are referred with a fair amount of probability, respectively, to *R. sivalensis* and *R. platyrhinus*. There now only remains *A. perimense*, to which the specimens may be referred, and they have accordingly been provisionally so assigned. This identification is rendered the more probable for the following reasons; firstly, the figured specimens come from a district of the Punjab where the remains of *A. perimense* are of extremely common occurrence; secondly, they are of relatively large size, and, therefore, accord well with the permanent teeth of that species; and, thirdly, they belong to the same species as two upper milk-molars from Burma, where only one species of fossil rhinoceros¹ is yet known to have existed. The latter teeth have already been figured in plate V, figure 4 of the first volume of this work, and were originally described on pages 45 and 46 as premolars, but not specifically determined. Subsequently, in the preface to the same volume (p. xiii), it was shown that these teeth were milk-molars, and that they might very probably belong to *R. iravadicus*. Since that species has been shown to be the same as *Acerotherium perimense*, the original inference with regard to the milk-molars would refer them to the latter species.

Description.—Reverting to the specimens figured in this volume, we find that the second milk-molar (*left of figure*) has been broken at its antero-external angle, but is otherwise complete; while the third milk-molar is complete, though slightly obscured by matrix posteriorly. Both teeth are about half worn down. In the smaller tooth, the anterior 'collis' is smaller than the posterior; the reverse being the case in the larger. The 'dorsum' of the smaller tooth shows that it carried, when complete, a single median and vertical ridge or 'costa'; the corresponding surface of

¹ On page 16 of the first volume of this series, it is stated by Mr. Foote that there were probably three species of fossil Burmese rhinoceros, and in support of this he cites three specimens. The first of these are some upper premolars figured by Clift, which correspond to the already described premolars of *A. perimense*. The second specimen is one of those on which *R. iravadicus* was founded, which is now shown to be the same as *A. perimense*. The third is the jaw containing the two associated upper milk-molars noticed above, which also seem to belong to the same species.

the larger tooth was produced into a 'buttress' formed by two similar ridges at the antero-external angle, and also carries a fainter 'costa' opposite the 'posterior collis.' In the smaller tooth there appears to be a small 'combing-plate' projecting from the external wall into the 'median valley' and uniting with the 'crochet'; while the latter extended completely across the valley to join the 'anterior collis.' The union of these processes, in the worn condition of the specimen, has resulted in the formation of three 'fossettes' in the 'median valley.' In the larger tooth there is no 'combing-plate,' and the 'crochet' does not extend completely across the 'median valley.' The 'cingulum' is only distinctly developed on the anterior surface of the teeth, and there is no tubercle at the entrance to the 'median valley.' The dimensions of these two teeth are as follows:—

Length of 2nd milk-molar	.	.	.	.	.	.	.	1·8
Width of „ „	.	.	.	.	.	.	.	1·7
Length of 3rd milk-molar	.	.	.	.	.	.	.	2·0
Width of „ „	.	.	.	.	.	.	.	2·15

The corresponding teeth of the opposite side from Burma, figured and described in the first volume, are less worn than the present specimens, and are also of somewhat smaller size. In all essential characters, however, the two specimens agree precisely. The 'buttress' at the antero-external angle of the third milk-molar from Burma appears somewhat less developed than in the corresponding Punjab tooth; this, however, is merely due to the difference in the condition of wear of the two specimens.

Comparisons.—On the assumption that the milk-teeth described above belong to *Acerotherium perimense*, it will be apparent that they differ from the teeth of the permanent series by the much slighter development of the 'cingulum,' and by the presence of a 'combing-plate' in the second milk-molar. These differences, however, should not be taken as affording indications of specific distinctness, as it appears to be not unfrequently the case that in animals of this family the milk-molars differ somewhat from the permanent teeth. Very analogous differences are to be observed between the permanent and the milk-molars of the living African *R. bicornis* as figured by De Blainville.¹ In that species the upper true molars show a distinct 'cingulum,' and either a very small or no 'combing-plate.' In the milk-molars, on the other hand, there is scarcely any 'cingulum,' and a large 'combing-plate.'

Upper incisor.—In figure 4 of plate III a very fine specimen of the unworn germ of an upper incisor of a rhinoceros is figured, which must probably be referred to the present species. This specimen was discovered by Mr. Theobald in the Siwaliks of the Punjab, and has been already referred to, under the name of *Rhinoceros planidens* in the "Records."² The grounds of assigning this tooth to *A. perimense* are, firstly, that it was found in the district where remains of that species are of such common occurrence; secondly, the large size of the tooth itself, which renders

¹ "Ostéographie" Atlas, genus *Rhinoceros*.

² Vol. XI, p. 98.

it much too large to have belonged to *R. sivalensis*, which is the other common Punjab species, the large *R. platyrhinus* being apparently unrepresented there¹; and, thirdly all the other known species of *Acerotherium* were provided with large upper and lower incisors. The specimen is viewed from the inside, because a great part of the outer surface has been broken away, leaving merely a cast of the pulp-cavity.² The tooth had not cut the gum at the time of the death of its owner, and therefore exhibits its outline to perfection. The lithograph gives a good idea of its form, and as this does not differ in any material point from that of other incisors of the family, no description is necessary. The length of the specimen is 4·3 inches, its thickness 1·5 inches, and the height of the crown 1·9 inches. This tooth indicates an animal of gigantic dimensions. Another very similar, but much worn tooth was also obtained by Mr. Theobald in the same district of the Punjab. It is not possible to say whether *A. perimense* was furnished with a second pair of upper incisors.

Mandible.—The mandible of a rhinoceros of which two portions are figured on plate IV of this volume, is another specimen from Mr. Theobald's Punjab collection. It was obtained from the same district as several of the upper molars of *Acerotherium perimense*, and has been already shortly noticed in the "Records"³ under the name of *Rhinoceros planidens*. The main reasons for assigning it to the present species are, from its association with the upper molars, from its large size, and greatly-developed incisors, so characteristic of the genus *Acerotherium*; and also from the presence of a 'cingulum' on the outer surfaces of the molars, which is likewise, according to Professor Gaudry, a characteristic of that genus.⁴ This reference is confirmed by the fact that three other forms of mandible of rhinoceros have been obtained from the Siwaliks, and have been respectively assigned to the three species of true *Rhinoceros*, in regard to which more will be said in the sequel.

The specimen under consideration consists of two portions, the larger of which (figure 1) comprises the symphysis and a considerable portion of the right ramus of the mandible. This fragment shows four molar teeth, the three first of which are fairly perfect, while the last (m 1) has been considerably injured, only its central portion now remaining. This tooth being more worn than the three earlier teeth must be the first true molar, the other three being the three last of the pre-molar series. On either side of the symphysis there is a single huge incisor: the one on the right side (in) has only lost its tip; while that on the left side has been broken off level with the alveolus, and is not shown in the figure: the outer side of this alveolus exposes the base of this incisor for a length of some five inches, with but little diminution in size. The right incisor shows that the protruded portion presented a flattened surface superiorly, looking upwards and inwards, while the

¹ 'R. G. S. I.,' Vol. XI, p. 95.

² The specimen was lithographed during my absence, and has unfortunately not been drawn in its natural position. The left-hand border should have been placed inferiorly.

³ Vol. XI, p. 97.

⁴ See "Les Enchainements du Monde Animal, etc.," p. 58.