inferior and external surfaces are rounded: the tooth is strongly curved upwards, and extends above the plane of the grinding surfaces of the molars. A slight fracture of the portion of the symphysis between the two large incisors shows that no small median incisors were present. The bone of the jaw itself is so decayed and mixed up with the closely adherent matrix that it is no easy matter to detect its true form. The ramus is very noticeable for its great vertical depth; and the symphysis seems to be much like that of the Javan rhinoceros, except that the enormous size of the incisives renders its borders more swollen and protuberant.

Of the molar series, the three last premolars and the first true molars, as already stated, are shown in the portion of the right ramus (fig. 1): the fragment of the associated left ramus, represented in figure 2 of the same plate, shows two teeth, which, from their condition of wear, seem to be, respectively, the first and second true molars. The teeth of the molar series resemble those of living species of rhinoceros, with the exception that at the base of their external surfaces they carry a narrow but distinct 'cingulum,' thereby showing, as is pointed out by M. Gaudry in the passage already cited, an affinity with older forms of the order, like *Palæotherium*.

Comparisons and dimensions.—Of the three forms of lower jaws of rhinoceros exhibiting the symphysis, figured in the "Fauna Antiqua Sivalensis," the only one which agrees with the present specimen in the number of its anterior teeth is the one represented in figure 4 of plate LXXIV, which is there referred to *R. palæindicus*. A more perfect specimen of a similar lower jaw is represented in figure 3 of plate VI of this volume, and is inferred, like the first specimen, to belong rather to *R. sivalensis*. The much smaller size of these specimens, with the absence of a 'cingulum' on the molars, at once distinguishes them from the specimen before us. The dimensions of that specimen are as follows:—

Depth of ramus at last premolar	4·5
Length of symphysis	6·4
Vertical diameter of incisor	1·8
Transverse „ „ „	2·4
Length of remaining protruded portion of incisor	3·5
„ of three premolars	5·1
„ of 1st true molar	2·65
„ of 2nd „ „	2·8

Young jaw.—In figure 1 of plate III of this volume, there is represented an unworn tooth-germ of a rhinoceros in its alveolus. This specimen is contained in a fragment of the left ramus of a mandible from which the other teeth have disappeared. The figured tooth, of which the anterior crescent has been somewhat injured, from its large size not improbably belongs to the present species. It was obtained by Mr. Theobald from the Siwaliks of the Punjab, in company with numerous other remains of *Acerotherium perimense*. Behind the figured tooth there exists in the jaw the empty alveolus of a still larger tooth: from the small dimensions of the jaw, it is probable that the tooth remaining is the first true molar. Its

length is 3·3 inches, and the height of the inner column of the hinder crescent 1·9 inches. Other specimens of lower jaws in the Indian Museum from the Punjab, probably also belonging to the present species, have molars of even still larger dimensions.

Specimen figured in the "Fauna Antiqua Sivalensis."—In figure 13 of plate LXXV of the "Fauna Antiqua Sivalensis," a portion of the left ramus of the mandible of a rhinoceros from Perim Island is figured under the name of *R.* (*A?*) *perimensis*. This specimen shows the last premolar and the three true molars. In the post-humous descriptions of the plates of the "Fauna Antiqua Sivalensis"[1] the dimensions of the teeth of this specimen are given as follows:—"Length of first true molar, 1·15 inches; of second, 1·4 inches; of third, 1·5 inches." Now these dimensions exactly correspond with the length of the teeth in the figure; but at the bottom of the plate itself it is stated that all the figures are drawn of half the natural size, and I can therefore only come to the conclusion that the dimensions of the teeth are really double those given in the description. Hence we shall have—

Length of 1st true molar	2·3
„ of 2nd „ „	2·8
„ of 3rd „ „	3·0

These dimensions are very close to those of the specimens described above, and it, therefore, seems probable that the Perim specimen may be rightly referred to *A. perimense*. There are some signs of a 'cingulum' being represented in the last true molar, but the figure does not show this very clearly. The form of the teeth seems to agree very closely with that of the lower teeth figured in this volume.

Bombay specimen.—Another specimen from Perim Island, belonging to the Bombay Branch of the Royal Asiatic Society, and alluded to in the "Records,"[2] agrees exactly in dimensions with the above. It consists of the greater part of the left ramus and symphysis of the mandible, and shows most of the molar series. The broken symphysis exhibits a large incisive alveolus.

General characters of species.—The foregoing descriptions will have shown that *Acerotherium perimense* was a very large-sized species of hornless rhinoceros, furnished above with one large pair of incisors, and whose upper molar teeth were formed after the pattern of those of the Javan and Sumatran rhinoceroses, but which presented a less development of the 'crochet.' The lower jaw was provided with one huge pair of outer incisors, and with the normal complement of molar teeth, which were furnished with a distinct 'cingulum' externally.

Distribution.—Remains of *Acerotherium perimense* have been obtained from the ossiferous beds of Perim Island in the Gulf of Cambay, from the lower Manchhar beds of Sind, from the Siwaliks of the Punjab, and from the ossiferous beds of the valley of the lower Irawadi. No remains of the species have hitherto been obtained from the Siwaliks in the neighbourhood of Dehra Dún and the Jamna

[1] "Pal. Mem.," Vol. I, p. 517.

[2] Vol. XIV, p. 156.

river, and it therefore appears that the Burmese form, which seems to have belonged to a smaller race, was isolated from the other representatives of the species.

Genus II: RHINOCEROS, *Linné*.

Either one or two horns, or rudiments of such, always present; limbs tridactyle.

Species I. Rhinoceros sivalensis, Falconer and Cautley

Synonyms (?) Rhinoceros angustirictus, Falc. and Caut.
„ fossilis indicus, Baker and Durand.
Zalabis sivalensis, Cope.

Previous notices.—The earliest description of a fossil rhinoceros from the Siwaliks is one published by Messrs. Baker and Durand in 1836.[1] In that paper there is described a complete skull, various teeth, and limb-bones,—all illustrated by figures. The authors considered that their skull indicated an animal allied to the living *R. indicus*, and accordingly gave it the name of *R. indicus fossilis*. From their figures and descriptions it is evident that their skull belongs to the species which was subsequently named *R. sivalensis* by Falconer and Cautley. Messrs. Baker and Durand did not apparently closely examine the molars of their specimen, or they would have seen that it was more nearly allied to *R. javanicus* than to *R. indicus*. Messrs. Baker and Durand's paper is copied, without the illustrations, in the "Palæontological Memoirs" of Dr. Falconer.[2] The teeth of which figures are given in Messrs. Baker and Durand's paper apparently belong, as was suggested by the authors, to more than one species. The present name of the species appears to have been first applied to the specimens figured in the "Fauna Antiqua Sivalensis," which afford ample means of recognising the species. In Royle's "Illustrations of the Botany, &c., of the Himalaya Mountains," published in 1839, there appears a figure[3] of the upper jaw and dentition of a rhinoceros from the Siwaliks, which was subsequently copied in the "Fauna Antiqua Sivalensis,"[4] where it is assigned to the present species. In the "Palæontological Memoirs"[5] a very cursory notice of this and the other Siwalik species of the genus is given. In the course of that notice the editor quotes a passage from the "Odontography"[6] of Professor Owen in reference to one of the Siwalik species of rhinoceros, and adds a comment of his own which appears to have been the source of many subsequent errors. Professor Owen's statement is as follows: "In one of the extinct species of rhinoceros from the

[1] J. A. S. B. vol. V, p. 486. In the previous volume of the same journal (vol. IV, p. 706, 1835), among a list of Siwalik mammals given by Falconer and Cautley, occurs the name *Rhinoceros angustirictus;* it is probable that this name was originally applied to the present species, but subsequently replaced by *sivalensis*.

[2] Vol. I, p. 158 [3] Pl. VI, figs. 3, 6. [4] Pl. LXXIV, fig. 5. [5] *Loc. cit.*, p. 157. [6] Page 589.

Himalayan tertiary beds, Dr. Falconer informs me that there are six incisors in both jaws; the typical number was therefore retained in this ancient species as in the contemporary *Hippopotamus* of the same formations." It will be seen from this statement that no species was named in which the peculiarity was said to occur. The late Dr. Murchison (the editor of the "Palæontological Memoirs"), however, goes on to observe that from the evidence of certain lower jaws figured in the "Fauna Antiqua Sivalensis" under the names of *R. palæindicus* and *R. platyrhinus*, the peculiarity could not occur in either of those species, and accordingly says that *R. sivalensis* must be the species in which six incisors were developed. Dr. Murchison, however, entirely omits to mention that in the "Fauna Antiqua Sivalensis" there is figured a third form of lower jaw under the name of *R. sivalensis* in which there are no incisors at all.[1] As no complete set of the upper incisors of any of the species of the Siwalik rhinoceroses is known, there is, as I have already shown in the first volume of this series,[2] no evidence at all to show that any of the Siwalik species of rhinoceros presented any abnormality in their dentition.[3] The next notice of the species, of any importance, occurs in the previous volume of this series, where some molar teeth are described and figured, and where mention is made in the subsequently published preface of some later notices by other writers. In that preface[4] mention is made of the establishment of a new genus (*Zalabis*), for the reception of *R. sivalensis*, by Professor Cope; and it was then stated that the new genus would not stand, and it might have been added that there were no more grounds for referring *Rhinoceros sivalensis* to it than any other Siwalik representatives of the family, the original statements as to the alleged hexaprododont character of one species having been made to apply to *R. sivalensis* on false premises.[5] A notice by the late Professor Brandt, in which he proposed to unite this species and the next with *R. indicus*, has been already fully discussed in the preface to the first volume of this work.

Object of present notice.—In the present volume certain teeth, obtained since the notice in the first volume was written, and illustrating more fully the dentition of the species, have been figured. A re-determination of the lower jaw probably belonging to this species has also been made, and an imperfect skull, provisionally referred to a variety of this species, is also noticed.

Penultimate upper true molar.—On page 26 of the first volume of this work a fine specimen of the, probably, penultimate upper true molar of this species was described; the same specimen was also figured in plate V, fig. 5. In that description, however, it was not stated on what grounds the specimen was referred to

[1] Pl. LXXIV, fig. 6. [2] Page 53.

[3] It is impossible now to say on what grounds this statement of Falconer's rested, but it is quite clear from a passage in his writings said to have been written in 1839 (Pal. Mem. vol. I, p. 180) that at that time, at all events, he considered that no species of rhinoceros had the full complement of mammalian incisors.

[4] pp. ix, xii.

[5] Professor Gaudry ("Les Enchainements du Monde Animal, etc.," p. 50) has likewise followed the false lead, and says "D'après Falconer, le *Rhinoceros sivalensis* de l'Inde avait le devant de sa mâchoire inférieure armé de trois paires de dents."

R. sivalensis. These grounds were, firstly, that the tooth agreed, as far as could be judged from the different state of wear of the specimens, with the corresponding tooth of a skull of *R. sivalensis* in the Indian Museum; and secondly, with the corresponding tooth of the left side of a skull of the same species drawn in figure 5 of plate LXXIV of the "Fauna Antiqua Sivalensis," which, though unfortunately figured on a small scale, is a very perfect specimen.

In plate V, figures 1 and 2 of this volume, two specimens of the penultimate upper true molar of this species have been figured in order to illustrate more fully this tooth in different stages of wear, and also to indicate the distribution of the species. The first specimen (figure 1) was obtained by Mr. Theobald from the Siwaliks of the Punjab, and the second by Mr. Fedden from the lower Manchhars of Sind. It will be unnecessary on this occasion to describe these teeth in detail, as this has already been done when treating of the specimen figured in the first volume, above referred to. A comparison of the figures will show that the three specimens present the same general characteristics in spite of some minor individual peculiarities, and the different conditions of their wear. In the latter respect, the Sind specimen is the least worn, the specimen represented in plate V, figure 5 of the first volume rather more worn, and the specimen in plate V, figure 1 of this volume the most so. The latter specimen appears to agree with the original specimen in all characters except the relative development of the 'crochet,' which is very much smaller: I cannot, however, think that this can be reckoned as more than an individual variation. The Sind specimen had originally a well-developed 'crochet,' but this has been broken away, and the point of attachment is difficult to show well in a figure.

This specimen, however, differs from either of the others in having a vertical groove on the posterior aspect of the 'anterior collis' corresponding to a similar groove on the anterior aspect of the same part occurring in all the specimens. Externally to this groove there is a slight swelling of the 'collis' jutting forth into the 'median valley.' The 'posterior valley' of the Sind specimen differs slightly from that of the specimen figured in the first volume. In the latter this valley forms an almost completely circular pit; while in the former its antero-posterior diameter is longer than its transverse: in this respect the specimen drawn in plate V, figure 1 of this volume is intermediate between the other two. A very slight trace of a tubercle can be detected at the entrance to the 'median valley' in the Sind specimen. I cannot consider that these slight variations, in the absence of any other more decisive evidence, can be considered as anything more than individual peculiarities. The variations in the Sind specimen are of considerable importance in identifying other specimens with the present species, as will be seen in the sequel.

Resemblance to R. javanicus.—In the previous volume, it has been mentioned that the upper molars of *R. sivalensis* resemble those of *R. javanicus* and *R. sumatrensis.* Certain points of alleged difference there pointed out seem, however, to be based on individual peculiarities, and are not of general applicability. The re-

semblance is, therefore, much greater than was at first indicated. Professor Flower[1] has pointed out how very closely the molars of the two living species resemble one another, but has shown that in *R. sumatrensis* the 'posterior valley' is relatively deeper than in *R. javanicus*, and consequently that on the worn masticating surface of the former, two 'fossettes' (fossæ) exist for a longer time than in the latter. In this respect the molars of *R. sivalensis* agree with those of *R. javanicus*, the 'posterior valley' being shallower than the median, and consequently the 'posterior fossette' disappearing at an earlier period than the median. This is well shown in the first true molar of the skull figured in plate LXXIV, figure 5 of the "Fauna Antiqua Sivalensis," and in two skulls in the Indian Museum. This being so, and seeing that *R. sumatrensis* is further broadly distinguished by its bicorn character, and by the relations of the inferior processes of the squamosal, we may confine ourselves to a comparison with *R. javanicus*. Between the true molars of these two species, taking into consideration the small variation which I have noticed in those of the fossil, I am totally unable to discover more than one point in their plan of structure which can be taken as affording any certain indication of distinction. This point is a difference in the relative dimensions of the molars of the two species. Taking little worn teeth, we shall find that in *R. sivalensis* the greatest length of the anterior surface, measuring to the second 'costa' of the 'buttress,' is exactly equal to the greatest length of the external surface; whereas in *R. javanicus* the former measurement is greater than the latter. The following measurements show this relationship: the two teeth of *R. sivalensis*, of which the dimensions are given, are the specimens figured in this volume (plate V, fig. 2), and in the preceding volume (plate V, fig. 5): the measurements of *R. javanicus* are taken from the teeth of a skull in the Indian Museum, and from another in my own possession; two other specimens in the former collection present the same characters :—

	R. sivalensis		*R. javanicus.*	
	a.	*b.*	*a.*	*b.*
Greatest length of outer surface	2·5	2·61	2·0	2·1
„ „ of anterior „	2·49	2·6	2·22	2·32

In all the specimens that I can procure this relation appears to be constant. In the relation of the transverse to the longitudinal diameter, the teeth of *R. sivalensis* agree with those of *R. sumatrensis*, but, as already said, differ in other points. Mr. Busk pointed out this difference in the relative diameters of the teeth of *R. sumatrensis* and *R. javanicus*[2]; but his conclusions were doubted by Professor Flower.[3] In such specimens as I have examined the relation is constant. It might be thought that size alone would afford sufficient grounds of distinction between the molars of *R. sivalensis* and those of *R. javanicus*, but although those of the former species are in general considerably the large of the two, a specimen described in the sequel as a probable variety of *R. sivalensis* has molar teeth of the same size as those of *R. javanicus*. It will be seen from the above comparisons how very closely the upper

[1] P. Z. S., 1876, p. 449. [2] P. Z. S., 1869, p. 413. [3] *Loc. cit.*

true molars of these two species resemble one another; and it appears to be very questionable whether, if we had only the teeth to deal with, there would be sufficient grounds for specific distinction.[1] This is, however, abundantly afforded by the difference in the form of the skulls.

Germ of upper true molar.—In figure 5 of plate V, there is figured a germ specimen of a first or second upper true molar, presenting all the characters of the teeth of *R. sivalensis*. This specimen was obtained by Mr. Theobald from the Siwaliks of the Punjab, and is quite uninjured. The base of the tooth has not yet attained its full size, but the summits of the ridges are of the same length as in the fully formed teeth of the species. The 'crochet' bifurcates at its extremity, and on the external or 'dorsal' surface of the crown there are seen to be two faint median ridges, which seem to disappear in the adult teeth.

Baker and Durand's specimen.—In figure 8 of plate IV of the first volume of this work, a molar of a Siwalik rhinoceros, copied from one of the plates of the above-quoted memoir of Messrs. Baker and Durand, was figured under the name of *R. sivalensis*. The teeth above described seem to show that the specimen in question must belong to another species, possibly to *R. palæindicus*.

Last upper true molar.—In figure 2 of plate IV of the first volume of this work, there is figured a much worn specimen of the last upper true molar of the present species. That specimen belongs to a cranium in the Indian Museum, agreeing in all respects with the figures of the skulls of *R. sivalensis* given by Messrs. Baker and Durand, and in the "Fauna Antiqua Sivalensis"; the specimen is, however, so much worn that the main characters of the tooth are not well shown, and, accordingly, another and less worn specimen has been figured in the present volume (pl. V, fig. 4). This specimen, which belongs to the left side, was obtained, in company with its fellow of the opposite side, by Mr. Theobald in the Siwaliks of the Punjab: a portion of the summit of the crown has been broken away at its antero-external angle, but the specimen is otherwise uninjured; it is in an early state of wear. The specimen is characterised by the prominent 'buttress' at the antero-external angle, by the simple 'crochet,' absence of 'combing-plate,' and wide 'median valley,' without any trace of a tubercle at the entrance. The 'anterior valley' forms a triangular platform on the side of the 'anterior collis': a faint tubercle at the postero-internal angle of the crown indicates a rudiment of the 'posterior valley,'—a rudiment frequently still more marked in *R. javanicus*. The tooth agrees very closely as regards form with the corresponding molar of he latter species; the following measurements showing the difference in the size of the two specimens:—

	R. sivalensis.	*R. javanicus.*
Length of internal surface	2·0	1 6
„ of anterior „	2·3	1·95
„ of external „	2·4	1·9

[1] The similarity of the teeth of these two species induced me to put in a proviso in this respect as to the identification of the Narbada rhinoceros with the living *R. indicus*.—Supra, Vol. I, Preface, p. viii.

The specimen, as far as can be judged from the small figure in the "Fauna Antiqua Sivalensis,"[1] is distinguished from the corresponding molar of *R. palæindicus* by the presence of the large 'buttress' at the antero-external angle, which is wanting in the latter. It is distinguished from the corresponding molar of *R. platyrhinus* by the absence of a 'combing-plate.'

The specimen figured in the preceding volume shows that when worn down only a single 'fossette' would remain on the crown, and this would be the case with the specimen figured here. In the specimen on the opposite side of the skull of which one tooth is figured in the first volume, the 'crochet' extends completely across the 'median valley,' so as to cut off an 'accessory fossette.' A detached specimen of a last upper true molar in the Indian Museum, from the Punjab, apparently belonging to the same species, shows a distinctly double 'crochet.'

Third upper premolar.—The specimen drawn in plate V., figure 6, so closely resembles the third or penultimate right upper premolar of *R. javanicus*, that, judging from the similarity of the true molars of the two species, there can be little doubt but that it is the corresponding tooth of *R. sivalensis*. It was obtained from the Siwaliks of the Punjab by Mr. Theobald: it is quite perfect, and about one-third worn down. The characteristic features of this tooth are the following. The 'posterior valley' forms a funnel-shaped pit, apparently nearly as deep as the 'median valley:' the 'anterior collis' is considerably larger than the posterior, and the 'crochet' is double or bifurcate: there is no 'combing-plate.' The external, or dorsal, surface shows two 'costæ,' the posterior of which is slightly, and the anterior very strongly, developed; the antero-external angle is produced into an acute process, and this, together with the anterior 'costa,' shows a tendency to the formation of the 'buttress' so characteristic of the true molars; the whole 'dorsal' surface, however, remains approximately straight, and not highly curved, as in the true molars. There is a faint trace of a 'cingulum' on the internal surface. The following dimensions show the relations of this specimen with the corresponding tooth of *R. javanicus*:—

	R. sivalensis.	*R. javanicus.*
Length of internal surface	1·2	1·0
„ of anterior „	2·1	1·8
„ of external „	1·6	1·5
„ of posterior „	1·7	1·6

Almost the only difference that can be detected between these two teeth is that in the fossil species the double 'crochet' is thicker and larger than in the living. According to Professor Flower[2] the double 'crochet' of the premolars of *R. javanicus* is a distinctive character of that species; never occurring in, the otherwise very similar, teeth of *R. sumatrensis*. The occurrence of a similar peculiarity in (at all events some of) the premolars of *R. sivalensis* is another indication of the close affinity of that species with the Javan rhinoceros. It may be added that some

[1] Pl. LXXIV, fig. 2*a*.

[2] *Loc. cit.* p. 449.

skulls of *R. javanicus* in the Indian Museum show a double 'crochet' in the first true molar; and we have seen a probable instance of the same in the last true molar of *R. sivalensis*.

Second upper premolar.—The last specimen of the permanent upper dentition of this species, we have to consider, is the specimen represented in plate V, figure 3. This tooth is also from Mr. Theobald's Punjab collection: it is much worn down. From its general resemblance to the second (ante-penultimate) left upper premolar of *R. javanicus*, it is inferred to be probably the corresponding tooth of *R. sivalensis*. The tooth clearly exhibits the much smaller depth of the posterior as compared with the 'median valley'; the former being nearly obliterated, and the latter still very deep. The only points by which this specimen can be distinguished from the corresponding tooth of the Javan rhinoceros are its larger size, and the somewhat greater development of the 'cingulum' on the internal surface.

Upper milk-molars.—In figure 2 of plate VI are represented three upper milk-molar teeth of a rhinoceros, obtained by Mr. Theobald from the Siwaliks of the Punjab, and probably belonging to *R. sivalensis*. The specimens figured are from the left side of the skull, but the corresponding teeth of the opposite side were also found with them. With regard to the species to which these teeth should be referred, it will be seen from what has been previously written that they do not belong to *Acerotherium perimense;* it will be shown subsequently that they certainly do not belong to *R. palæindicus;* while from the absence of a 'combing-plate' in the hindmost, they do not belong to *R. platyrhinus*, an inference confirmed by the absence hitherto of all remains of that species in the Punjab. There accordingly only remains *R. sivalensis*, to which they can be assigned; and we have, therefore, only to consider the serial position of these teeth. From the antero-posteriorly elongated form of the anterior tooth (mm. 2), it might at first sight be thought that the teeth are the first three of the milk-molar series, but the complex form of the first tooth (having complete anterior and posterior 'colles'), together with the form of the second tooth, seems to forbid this view. In respect to the latter point, it may be observed that there are no instances known to me in which the second upper milk-molar of a rhinoceros has the anterior 'costa' approximated to the antero-external angle (as in the middle tooth, mm. 3 of our specimen); the position of this 'costa' being central, or sub-central if distinctly developed at all. It seems, therefore, that the teeth under consideration are (reckoning from left to right) respectively, the second, third, and fourth of the deciduous series. On this assumption the first milk-molar must have been an exceedingly small tooth, and was probably shed in very early life.[1] In this respect, *R. sivalensis* agrees with *R. javanicus*, which is distinguished from *R. indicus* by the smaller size of this tooth, and by the earlier time at which it is shed.

The second milk-molar (mm. 2 in figure 2) is an irregularly-shaped tooth,

[1] A very minute undescribed tooth in the Indian Museum is not improbably the first upper milk-molar of this species.

the anterior side being produced into a sharp process; posteriorly to this process the external surface is convex, showing two faint 'costæ' opposite the 'collis.' The 'anterior collis' is flattened internally, and throws off an oblique ridge to join the outer wall of the tooth: from the ridge connecting the 'posterior collis' with the outer wall, there is given off a long 'crochet,' projecting into the 'median valley.' There is a distinct 'cingulum' on the anterior and posterior walls of the tooth. The third and fourth (penultimate and last) milk-molars resemble normal rhinoceros molars, and, therefore, require no detailed description. In the penultimate tooth the 'crochet' is united to a small 'combing-plate,' thus cutting off an 'accessory fossette.' In both teeth there is a distinct ridge projecting from the hinder side of the 'anterior collis' into the 'median valley,' which may be called an 'anti-crochet.' On the external surface of each tooth the anterior 'costa' is placed close to the antero-external angle of the crown, which is produced into a sharp process, the two ridges tending to the formation of a 'buttress,' which, however, is not so marked as in the true molars, the external surface being consequently less curved than in the latter. The teeth are about the size of the upper milk-molars of *R. sumatrensis*, and, therefore, proportionately somewhat smaller than the true molars. A detached specimen, otherwise indistinguishable from the last tooth, has the anterior 'collis' without an 'anti-crochet'; there is, therefore, the same variability in this respect in the milk-molars that we have seen to occur in the true molars. The specimen of a young maxilla of a rhinoceros represented in figure 3 of plate XIX of Messrs. Baker and Durand's memoir, containing the four milk-molars, probably belongs to the same species as the present specimen. The dimensions of the figured specimen will be found under the head of *R. palæindicus*. (p. 47.)

Comparisons between milk-molars.—From the above description it appears that the milk-molars provisionally assigned to *R. sivalensis* differ from the true molars by the occasional presence of a 'combing-plate,' and in the less development of the 'buttress' at the antero-external angle, and it is, therefore, incumbent on us to see whether analogous differences occur between the corresponding teeth of allied living species. There is unfortunately no specimen of the milk-molar dentition of *R. javanicus* available to me; but there are two skulls of *R. sumatrensis* (in which, as we have seen, the general form of the teeth is very like that of *R. javanicus*) in the Indian Museum, showing the deciduous dentition. In one of these specimens a 'combing-plate' occurs in the penultimate milk-molar, as in our specimen of the milk-molars of *R. sivalensis*, and none in the last. In the two last milk-molars of the living species, the 'buttress' at the antero-external angle is less produced than in the true molars. Hence the external wall of the two milk-molars, when the teeth are in the jaw, is nearly coincident with the long axis of the skull, while in the true molars the corresponding surface forms a large angle with the same axis. If the last milk-molar of *R. sivalensis* were fully protruded, the outer surface of this and the anterior tooth would likewise be nearly

coincident with the long axis of the jaw. It is thus apparent that the differences existing between the teeth, which we have considered as the deciduous and permanent molars of the fossil Siwalik rhinoceros, are paralleled by corresponding differences between the homologous teeth of a living species with very similarly formed teeth, and there is accordingly a presumption of the correctness of the reference.

General remarks on the upper molar dentition of the Rhinocerotidæ.—It has been shown from the preceding comparisons that in, at all events, some of the species of rhinoceros, whose upper molars are formed on the plan of those of the living Javan and Sumatran species, the milk-molars present a less degree of specialisation than the true molars in regard to the relative development of the so-called 'buttress' at the antero-external angle. If, however, we turn to other species, like *R. indicus*, in which there is no distinct 'buttress' developed in the upper true molars, it will be found that in the milk-molars there occurs an approach to this 'buttress,' very like that which occurs in the milk-molars of the *R. sumatrensis* type.[1] Indeed, in place of the very wide difference occurring between the true molars of *R. indicus* and *R. sumatrensis*, there is only a comparatively very slight difference between their milk-molars. Now, at all events, the greater number of the old forms of the Rhinocerotidæ (*Acerotherium*, and I believe all the miocene species of *Rhinoceros*) possess teeth of the Sumatran type, which approaches the type of the teeth of other old perissodactyles, such as *Palæotherium*, *Anchitherium*, *Hyachyus*, &c., and it is therefore pretty clear that this form of molar is the oldest. This, then, will explain the resemblance existing between the milk-molars of species whose true molars are formed, respectively, on the Sumatran and Indian types, it being not uncommon for ancestral characters to be retained in the deciduous series, which have long since disappeared in the permanent. It would be a necessary consequence of this hypothesis that species having teeth of the Indian type should be of comparatively recent origin, and such, indeed, appears to be the case. The earliest form seems to be the Siwalik *R. platyrhinus*, apparently only found in such parts of the Siwaliks as are without much doubt of pliocene age, and never occurring in the older Punjab and Sind beds; in the pleistocene we have *R. tichorhinus*, and at the present time *R. indicus* and *R. simus*. There also exist intermediate forms, which seem to have originated in the pliocene, and still live on; these have teeth without the distinct 'buttress' of the Sumatran type, but the 'crochet' and 'combing-plate' do not unite to cut off an accessory 'fossette,' as in the Indian type, and the latter may be absent; these intermediate forms are exemplified by the fossil *Rhinoceros etruscus*, *R. leptorhinus* (Owen) and the living African *R. bicornis*. If these conclusions be true, the Sumatran and Javan rhinoceroses must be considered as being the little altered descendants of a very old type, while *R. indicus* is a much more specialised form of later origin.

Mandibles of Siwalik rhinoceroses.—The authors of the "Fauna Antiqua

[1] This character is shown to a certain extent in the specimens of the milk-molar dentition of *R. indicus* figured by the author in the 'Jour. As. Soc., Bengal' (Vol. XLIX, pt. II, pl. VII), but more clearly in still younger specimens.

Sivalensis" have figured three distinct forms of the symphysis of the mandible of Siwalik rhinoceroses, which they have respectively referred to the three species named by them from the sub-Himalaya. In the first volume of this work I accepted these determinations, though a proviso was added in the preface that I was unaware on what grounds they rested. A subsequent reconsideration of the question has now convinced me that these determinations, in support of which there is no available evidence, are probably incorrect, and I shall accordingly proceed to show on what grounds they may be objected to. Before going further, however, it may be premised that from the remarkable similarity in the form of the lower molars of all species of rhinoceroses, it is a matter of extreme difficulty to specifically distinguish fragmentary fossil jaws not showing the symphysis, and accordingly only such specimens as exhibit this portion will be entirely relied upon for specific distinction. It appears indeed, to me, to be very problematical whether it would be possible to distinguish the lower molars of the living species, if removed from the characteristic parts of the mandible.

Of the specimens figured by Falconer and Cautley, the first is a jaw with the symphysis (pl. LXXIV, fig. 6), which seems to have carried no incisors, and in which the molar series extended far over the symphysis.[1] This specimen has been referred to *R. sivalensis*, and seems to be most nearly related to the mandibles of the pleistocene European and the living African rhinoceroses. The second form (pl. LXXIV, fig. 4) shows merely the symphysis, which carries a large pair of outer incisors, and apparently no median pair; the central part of this symphysis forms a uniform channel, sloping regularly from before backwards as in the Javan rhinoceros. This specimen has been referred to *R. palæindicus*. The third form is exemplified by two specimens, one of which (pl. LXXII, fig. 4) exhibits only the symphysis, while the other (pl. LXXV, fig. 10) shows the rami as well. In this form the symphysis carries a pair of large outer incisors, and another pair of very small inner ones; the central portion of this symphysis forms a channel which is convex in the middle of its course, as in *R. indicus*. This form has been referred to *R. platyrhinus*.

In the Indian Museum the only specimens (exclusive of the mandible of *Acerotherium perimense*) of the symphysis of the mandible of Siwalik rhinoceroses are two; one of these is merely a symphysis, and agrees with the form referred by Falconer and Cautley to *R. platyrhinus*: this specimen was obtained from the eastern Siwaliks in the neighbourhood of the river Jamna. The second specimen (pl. VI, fig. 3) agrees with the form referred by Falconer and Cautley to *R. palæindicus*, and was obtained by Mr. Theobald from the Siwaliks of the western Punjab.

With regard to the case of *R. sivalensis*, we have already shown that this is a unicorn species, showing great affinities in the form of its molars to the living *R. javanicus*. This being so, it is in the highest degree improbable that it was fur-

[1] From the description of this specimen in the index to the plates, the symphysis appears to be imperfect, and may have been produced into a spatulate form.

nished with a lower jaw totally unlike that of the latter species, and nearly resembling the jaws of the bicorn living African or pleistocene European species. Again, no known unicorn species, either recent or fossil, has a mandible unprovided with incisors, like the one referred by Falconer and Cautley to the unicorn *R. sivalensis*. Hence there is a very strong presumption indeed that the Siwalik lower jaw without incisors belonged to a bicorned species, while to *R. sivalensis* there belonged one of the two forms of tusked lower jaws referred by Falconer and Cautley to the other two Siwalik species. This inference is supported by the fact that in the Punjab none of the numerous mandibles of fossil rhinoceroses collected by Mr. Theobald belong to the form referred to *R. sivalensis*,[1] while nearly all the upper molars (except those of *Acerotherium*) belong to *R. sivalensis*, and none to *R. platyrhinus*. Falconer's determination would, therefore, drive us into the double dilemma of, firstly, referring to a species closely allied to the Javan rhinoceros, a form of jaw nearly resembling that of a bicorn species; and, secondly, of finding no lower jaws of a species in a district where its upper jaws and skulls are of comparatively common occurrence. I therefore conclude that Falconer and Cautley's determination of the lower jaw of *R. sivalensis* is probably incorrect.

From this it will be clear that one of the forms of mandible referred by Falconer and Cautley respectively to *R. palæindicus* and *R. platyrhinus* will probably belong to *R. sivalensis*. Now of these two, I find that the one referred to *R. palæindicus* approaches most nearly in general form to the mandible of *R. javanicus*, and that this one appears to be the most common in the Punjab where *R. sivalensis* is the prevailing species. It is true, indeed, that in the presence of median incisors the mandible referred by Falconer and Cautley to *R. platyrhinus* agrees more closely with the mandible of *R. javanicus*, but its general form is different, and it is by no means certain that small median incisors may not have been developed in the jaw I have provisionally assigned to *R. sivalensis*, and have been shed at an early period.

There now comes the question as to which of the two remaining lower jaws should be assigned respectively to *R. platyrhinus* and *R. palæindicus*. The former species, as has been already stated, is a bicorn form, and, as will be shown subsequently, has upper molars formed on the complex Indian type. Now, the only species of rhinoceroses known to me, which are bicorn, and furnished with permanent lower incisors, are *R. sumatrensis* (?=*R. lasiotis*) and *R. schleiermacheri*, and these have upper molars of the simple or Sumatran type. No bicorn species with teeth of the Indian type ever have permanent outer incisors,[2] though some species without incisors have molar teeth of the Sumatran or intermediate type; e.g., *R. bicornis*, *R. etruscus*, *R. leptorhinus* (Owen), *R. megarhinus*, *R. pachygnathus*, *R. tichorhinus*. Finally, as already said, there is no known instance of an

[1] Although these specimens, with one exception, do not show the symphysis, many of them show the whole of the premolar dentition, which, in the form referred by F. and C. to *R. sivalensis*, is placed directly on the symphysis; the specimens therefore indicate a form with a produced symphysis.

[2] According to M. Gaudry. (*loc. cit.* p. 52), *R. pachygnathus* and *R. leptorhinus* sometimes develope very minute inenr incisors.

unicorn species having been unprovided with lower incisors. The balance of evidence therefore seems to be strongly in favour of the view that the form of Siwalik jaw without incisors should be referred to *R. platyrhinus*. This being so, the remaining jaw, with two pairs of incisors, must belong to *R. palæindicus*.

If the above determinations be correct, the specimens figured in the "Fauna Antiqua Sivalensis," must be redistributed as follows:—

R. sivalensis, plate 74, figs. 3, 4.
R. platyrhinus, „ „ fig. 6; pl. 75, fig. 6.
R. palæindicus, „ 72, „ 4; „ „ „ 10.

Mandible of R. sivalensis—Assuming that the mandible, of which a figure, half the natural size, is given in plate VI, figure 3 of this volume, belongs to *Rhinoceros sivalensis*, we may proceed to the description of the specimen. It consists of the symphysis, and the left horizontal ramus of the mandible, showing the sockets of two incisors, and six complete molar teeth. Of the latter, the three last (m. 1. m. 2. m. 3) belong to the true molar, and the three earlier to the premolar series; the latter determination being made from the fact that the fourth tooth, counting from the left (m. 1), is more worn than the third tooth. The last true molar, though fully protruded from the alveolus, has not been touched by wear, so that the animal had only just attained its full development at the time of its death. The form of the whole jaw and teeth is so close to that of the corresponding parts of *R. javanicus* that it would be waste of words to give a detailed description; and it will, therefore, be sufficient to give the measurements of the two specimens. It may, however, be noticed that both specimens agree in the absence of the first premolar, which in the living form is very generally shed at an early period; this is in contrast to what occurs in *R. indicus* where the first premolar as frequently persists. Apart from the smaller size of the recent specimen, the only important difference that can be detected between the two is the absence of the alveoli of median incisors in the fossil. This no doubt is a very important point of difference, and it is somewhat difficult to account for the presence of these teeth in *R. javanicus*, if, as the other evidence seems to indicate, that species be the descendant of *R. sivalensis*. It is, however, quite possible, as already mentioned, that the latter species may have developed median incisors in the young state. The following table gives the dimensions of the jaws of the two species:—

	R. sivalensis.	*R. javanicus.*
Length of six molars	11·0	9·0
Length of first premolar	1·3	1·1
Height of „ „ (slightly worn)	1·1	1·0
Length of last true molar	2·1	1·73
Height of „ „	1·56	1·22
Depth of jaw at first true molar	3·3	2·4
Width of narrowest pt. of symphysis	3·4	2·8
Long diameter of incisive alveolus	1·7	1·6
Shorter „ „ „	1·1	0·9

The specimen of the symphysis figured in the "Fauna Antiqua Sivalensis," already referred to, is somewhat wider; this additional width seems in great part due to pressure; there are, however, analogous differences in the width of the symphysis of the living species.

Var. GAJENSIS, Nobis.

Specimens.—The next specimens for consideration are the hinder portion of a skull and the upper molar of a rhinoceros, obtained by Mr. Fedden in Sind from a group of rocks known as the Gáj beds (plate V, fig. 7; plate VII, fig 1). The specimens in question are those on which rests the statement given in Mr. W. T. Blanford's "Geology of Western Sind",[1] that *R. sivalensis* occurs in the Gáj beds, and is the only mammal found in them. The age of these beds is given in the same memoir as being probably miocene, with a possibility of being the upper part of that period. This fossil is accordingly in all probability from a lower horizon than any of the other mammals from Sind and the Siwaliks, and its specific determination is therefore a matter of very considerable interest. In the course of the following description, there will be pointed out certain peculiarities in which the remains from the Gáj beds differ from the corresponding remains of type specimens of *R. sivalensis;* but it will also be shown that in regard to the teeth there is a transition from the type Siwalik forms to the Gáj form, and I have, therefore, come to the conclusion that it will be best to consider, at all events provisionally, the Gáj fossil as a variety of *R. sivalensis*, for which I propose the name *gajensis;* at the same time indicating the possibility of its specific distinctness.

Skull.—The fragment of the skull unfortunately alone remaining consists of the hinder half only (pl. VII, fig 1); this, however, is fairly perfect. This skull was found in company with two molars, one of which is figured in plate V, fig. 7, and was probably intact before it was extracted from its bed. The condition of the molars proves it to belong to an animal which had not attained its full dimensions. If the figure of the Gáj skull be compared with the corresponding part in the adult skulls of *R. sivalensis*, figured by Messrs. Baker and Durand,[2] by Falconer and Cautley,[3] and in this volume, it will be seen that the supra-occipital region in the former is not produced into such a high angular peak as in those specimens, while the Gáj skull is also of considerably smaller dimensions. We have, however, seen reason to believe that the latter belongs to an immature individual, and it is, therefore, not in a condition to afford well-marked specific characters. Seeing that in the large living unicorn Indian rhinoceros there is a very considerable difference n the relative development of the supra-occipital region according to age,[4] it is

[1] Mem. Geol. Surv. Ind., vol. XVII, p. 57. [2] *Loc. cit.*, pl. V, fig. 3. [3] 'F. A. S.' pl. LXXIII, fig. 2*a*.

[4] The non-development of the occipital region at an early age is well exhibited in a young skull of *R. indicus* figured by Dr. Gray ("Hand-list of Edentate, Thick-skinned, and Ruminant Mammals in the British Museum," pl. XIV). A good figure of an adult skull is given in De Blainville's "Ostèographie."

not improbable that the Gáj skull is not fully developed in this respect. Again, the hinder portion of a small skull of a fossil rhinoceros from the Siwaliks, figured by Messrs. Baker and Durand,[1] agrees with the Gáj specimen in size and form. This skull was considered by those writers as belonging to a young individual of *R. sivalensis;* and if this determination be correct, it would show that the Gáj specimen is probably a young individual of the same. On the whole, it seems to me probable that the Gáj skull would never have developed such a high occipital region as the typical skulls of *R. sivalensis;* but, as we shall see below, there is such an intimate connection between the upper molars of the two forms that there would be great difficulty in making any well-defined specific distinctions, although, as already said, there is a possibility of the specific distinctness of one form. The Gáj skull exhibits very clearly the union of the post-glenoid and post-tympanic processes of the squamosal below the auditory meatus, a character which it shares, as far as is known, with all unicorn members of the family.

Upper true molar.—The upper molar drawn in figure 7 of plate V is the one nearly perfect specimen found with the Sind skull; it has unfortunately been broken on the free edge of the outer wall: when perfect it could only have been just touched by wear on this outer side, as the summits of the two 'colles' are still intact. The antero-posterior elongation of this tooth shows that it cannot belong to the premolar series; while the great development of the 'buttress' at the antero-external angle, and the curvature of the external, or dorsal surface, equally shows that it cannot be a milk-molar. The specimen must, therefore, be either the first or the second true molar. If the figure of this tooth be compared with that of the second upper true molar of *R. sivalensis* drawn in figure 2 of the same plate, it will be seen that, except as regards size, the two are exceedingly alike. The only differences that I can detect are that in the smaller tooth the groove on the posterior aspect of the 'anterior collis' is more pronounced, and the ensuing accessory spur considerably more developed than in the larger specimen; in the former there is also a distinct tubercle at the entrance to the 'median valley,' of which only a trace exists in the larger. Both agree in the form of the 'posterior valley.' In the teeth which are here provisionally considered as the milk-molars of *R. sivalensis*, there is the same conformation of the 'anterior collis' as in the Gáj specimen; consequently, since ancestral characters are often retained in the milk-molars, and if all the teeth belong to the same species, it would seem that in the Gáj race the form of the 'anterior collis' was the most complex; in the higher Manchhar form it was slightly less so, and in the highest Siwalik form it had become quite simple, its original complexity being retained only in the milk-molars.

Seeing thus that a transition can be traced from the Gáj molar, through the Manchhar, to the Siwalik specimen, there appear to be no valid grounds for assigning the first to a distinct species; as, however, the Gáj form is of considerably smaller size than either of the others, and as it presents certain points of

[1] *Loc. cit.*, pl. XVII, fig. 9.

difference from the type, I propose, as already said, that it should be known, at all events for the present, as *Rhinoceros sivalensis* var. *gajensis*. If the Gáj specimen were assigned to a distinct species, it would then be impossible to say whether the Manchhar upper molar should be referred to this new species with which it agrees in form, or to *R. sivalensis* with which it agrees in size.

The dimensions of the Gáj specimen are compared below with those of the first upper true molar of *R. javanicus*, from which it will be seen that the two indicate an animal of the same size:—

	Var. gajensis.	R. javanicus.
Length of anterior surface	2·0	2·1
„ of outer „	2·05	1·86
„ of posterior „	1·6	1·9
„ of inner „	1·15	1·3

These measurements show that the same proportions pointed out above as distinguishing the larger teeth of *R. sivalensis* from those of *R. javanicus* prevail in the smaller Gáj variety of the former.

Distribution.—Remains of *Rhinoceros sivalensis* appear to have been obtained throughout the sub-Himalayan Siwaliks, from the Ganges to the Indus; they have also been obtained from the lower Manchhar beds of Sind; while the variety, *gajensis*, occurs in the Gáj beds of the latter country. No remains of the species have hitherto been identified either from Burma or from Perim Island.

Conclusion.—In conclusion, it may be predicated of *R. sivalensis*, if all the remains described above are correctly assigned to it, that it is an unicorn species, the form of whose cranium is intermediate between that of *R. indicus* and *R. javanicus*; and that its molar dentition and mandible are exceedingly like those of the latter, and very different from those of the former species. It is, however, distinguished from the latter by the absence of median lower incisors. It was represented in the undoubted miocene by a smaller form presenting slight differences in the form of the molars from the typical pliocene form, and it is also possible there was a slight difference in the shape of the cranium of the earlier form, making an approach to the cranium of *R. javanicus*. The balance of evidence seems therefore to point to the intimate relationship existing between *R. sivalensis* and *R. javanicus*, and to the probability of the one being the ancestor of the other. It is, however, as already said, somewhat difficult to understand the absence of median incisors in the adult fossil form; and also in a lesser degree the greater apparent specialisation in the form of the skull.

Species 2.—Rhinoceros palæindicus, Falconer and Cautley.

Previous notices.—As far as can be discovered, no description or notice of this species was ever published by the authors of the "Fauna Antiqua Sivalensis," and the first appearance of the name seems to have been in that work, where several

skulls and other remains are figured. In that work there are figured two specimens of adult skulls (pl. LXXIII, fig. 1; pl. LXXIV, fig. 2), and one of an immature skull (pl. LXXIV, fig. 1), showing the milk-molar dentition.[1] In pl. LXXV, fig. 1 of the same work, there is figured the left upper molar dentition of a rhinoceros under the same specific name. An upper tooth of the molar series is represented in figure 4 of the same plate. Specimens of a mandible referred to this species are also figured, but, as has been said in the description of the last species, I have not accepted this identification. A short notice of this species has been given in the preceding volume of this work,[2] but beyond this no important or original notice has ever been published. I accordingly proceed to notice briefly the leading characters of the more important specimens figured in the "Fauna Antiqua Sivalensis" (the dentition of one of which will be noticed more fully), and to describe certain teeth from the collection of the Indian Museum apparently belonging to this species. It may be added that there are exceedingly few remains in the latter collection which can be referred to this species.

Cranium.—As far as can be judged from the figures given in the "Fauna Antiqua Sivalensis," the cranium of this species indicates that it carried one very large nasal horn, and that the superior border was highly curved, but to a less extent than in the preceding species; it was also distinguished by its greater width across the frontals. A cast of the young skull, already referred to, shows that the inferior squamosal processes were united below the auditory meatus. Measurements of the skulls figured in the "Fauna Antiqua Sivalensis" are given in the descriptions of the plates of that work,[3] and this is about all that can be gathered from the materials at our disposal.

Upper molar dentition.—Among the crania figured in the "Fauna Antiqua Sivalensis," the specimen, of which the inferior aspect is represented in figure 2*a* of plate LXXIV, alone exhibits the greater part of the molar series in an intermediate condition of wear, and is accordingly the best adapted for studying the general characters of these teeth.[4] This specimen shows that the true molars are readily distinguished from those of *R. sivalensis* by the absence of any distinct 'buttress' at the antero-external angle, and also by the consequently much greater flatness of the external surface of each tooth. The molar teeth of both species agree in the presence of a distinct 'crochet,' and in the absence of a 'combing-plate.' Very frequently, in the upper molars of *R. palæindicus*, the 'crochet' extends completely across the 'median valley' so as to cut off from this valley a separate pit, which, when the crown is worn down, appears as a distinct island or 'fossette,' frequently termed the 'accessory fossette.' In this respect the true molars of *R. palæindicus* in many cases differ from those of *R. sivalensis*, but this does not appear to be an

[1] In the description of this figure, the specimen is erroneously said to show the permanent dentition.

[2] Page 22 *et seq.* [3] "Pal. Mem." Vol. I.

[4] It is impossible to avoid a certain repetition of the matter given in the first volume on this subject.

invariable point of distinction, as we have seen that a 'third fossette' is occasionally developed in some of the molars of the latter species, and it does not always appear to be present in those of the former.

The next specimen requiring notice is a detached upper molar, drawn of half the natural size in figure 4 of plate LXXV of the "Fauna Antiqua Sivalensis," and copied in figure 3 of plate IV of the first volume of this work. This tooth has a length of 2·5, and a breadth of 3·2 inches; it has hitherto been considered, following Falconer and Cautley, as a premolar, but its large size and proportionate length rather seem to indicate that it is a true molar, and it appears to agree precisely, both in form and size, with the right upper penultimate true molar of the skull drawn in plate LXXIV, figure 2*a* of the "Fauna Antiqua Sivalensis."

The last specimen of the upper molar dentition of this species figured in Falconer and Cautley's great work is contained in a detached specimen of the left maxilla showing the three true molars (pl. LXXV, fig. 1). In this specimen the teeth have the general characters of those of the other specimens, but, as far as can be judged from the figures, the external surface of the penultimate molar appears to be slightly more curved; this, however, does not appear to be a character of specific importance. The length of the penultimate tooth in that specimen is 2·4, and the width 3·2 inches.

Punjab specimen.—In plate VI, figure 1 of this volume are represented three associated upper molars of a fossil rhinoceros, which it seems probable should be referred to a small form of the present species. The figured teeth are contained in a portion of the left maxilla, collected by Mr. Theobald in the Siwaliks of the Punjab. That maxilla shows the broken base of a tooth to the right of the figured specimens, which is the remnant of the last true molar; the figured specimens will therefore be (counting from left to right) the last premolar and the first and second true molars. The whole of the three teeth are somewhat battered, but the premolar and the first true molar are fairly perfect; the second true molar has, however, lost its outer wall.

From the absence of any distinct 'buttress' at the antero-external angle of the first true molar, it is perfectly evident that these teeth can belong neither to *Acerotherium perimense* nor to *Rhinoceros sivalensis*. The want of a 'combing-plate' is equally convincing that they cannot belong to *R. platyrhinus*. Hence, unless they belong to a new species, they must be referred to *R. palæindicus*.

On comparing the two true molars of the specimen under consideration with the figures of the corresponding teeth of the specimen drawn in figure 1 of plate LXXV of the "Fauna Antiqua Sivalensis," the two appear to correspond very closely, except in the matter of size: it seems probable that in our specimen an 'accessory fossette' would be cut off from the 'median valley' in a more advanced state of wear. The premolar in our specimen has a wide ledge at the entrance of the 'median valley' forming a rudimentary 'cingulum.'

The dimensions of our specimen are as follows :—

Length of last premolar	1·4
Width of „ „	1·9
Length of first true molar	1·5
Width of „ „	2·05
Length of second „	1·9
Width of „ „	(?)2·4

These measurements show that there is a very considerable difference in the size of the two specimens; the dimensions of the second upper true molar of Falconer's specimen being 2·4×3·2 inches. The general resemblance between the teeth of the two specimens is, however, so close that I do not consider there is any evidence at present to warrant us in separating the two. We have already seen that the molars of Falconer's specimen seem to be slightly different from those of what may be called the type specimen, and in the Punjab specimen we have this slight difference in form accompanied by a difference in size. If all three specimens belong, as appears probably the case, to one species, we have another excellent instance of the variation to which a species may be subject.

British Museum skull of small race.—In the British Museum there is an imperfect cranium of a Siwalik rhinoceros, not figured in the "Fauna Antiqua Sivalensis," but labelled *R. palæindicus*, of which a cast is now in the Indian Museum. This cast shows that the cranium is imperfect superiorly, but the portion of the frontals remaining shows the great breadth characteristic of the skulls of *R. palæindicus*. The specimen exhibits the greater portion of the molar series of either side, but unfortunately every tooth has been split vertically and lost more or less of its outer half. The inner halves of the first and second true molars and the greater part of the two last premolars are fairly well exhibited. The true molars of this specimen, as far as can be judged from what remains of them, agree in general form with those last described, but are of slightly larger dimensions, thus breaking down the gap between the latter and Falconer's specimens. The premolars of this specimen, however, present a divergence in another direction. In place of having merely a small ledge at the entrance to the 'median valley,' as in the Punjab specimen, the last premolar has a distinct 'cingulum' along the whole of the inner side, and makes some approach to a tooth from Sind, represented in plate VI, figure 6 of the first volume of this work as a premolar of *Acerotherium perimense*. Taking into account, however, the resemblance of the skull in the British Museum to the skull of *R. palæindicus*, and of its true molars to those of the Punjab specimen, which we were unable to separate from that species, I cannot think the materials at present available would justify us in assigning the British Museum skull to a distinct species merely on account of the variation of one premolar. If this reference be correct, it shows how very uncertain must be any evidence, founded on a single premolar tooth, as to the species of its owner.

Last upper premolar.—In figure 2 of plate VII of this volume, there is represented one of two similar upper premolar teeth of a rhinoceros, obtained by Mr.

Theobald from the Siwaliks of the Punjab. The specimen figured is from the right side of the skull, and from its size is probably the last of the premolar series. With the exception of having been somewhat rolled on the outer surface, the specimen is perfect, and has been but slightly abraded by use. From a comparison of the figure with the figures of the upper premolars of *Acerotherium perimense* and *Rhinoceros sivalensis*, this tooth would seem not to belong to either of those species, the premolar of the former being characterised by its large 'cingulum,' and that of the latter by the greater development of the anterior 'costa,' and consequently greater flexure of the external surface. The last premolar of *R. platyrhinus* is distinguished by the presence of a distinct 'combing-plate.' It seems, therefore, not improbable that the tooth before us may be the last upper premolar of *R. palæindicus;* but as these teeth seem so liable to variation, it is not possible to be certain on this point. The tooth is characterised by the sub-equal size of the two 'colles'; by the presence of a small and slightly bifurcate 'crochet'; and by the absence of any distinct 'combing-plate': the external surface has two equal-sized 'costæ,' which have been somewhat worn away by rolling. As regards form, the tooth appears to agree with the last upper premolar drawn in figure 1 of plate VI, but is of larger size, and must have belonged to an animal of the dimensions of Falconer's type specimens. If this tooth be a premolar of *R. palæindicus*, it is quite evident that the detached tooth figured by Falconer as such, and already noticed, must be, as here considered, a true molar.

Upper milk-molars.—In figures 1, 1*a*, 1*b*, 1*c* of plate LXXIV of the "Fauna Antiqua Sivalensis" are given four views of a young skull of a Siwalik rhinoceros, referred by the authors of that work to *R. palæindicus :* the general form of the skull seems to indicate that such determination is probably correct. In the post-humous descriptions of the plates, the specimen is said to show the permanent dentition, and this determination was originally accepted in the first volume of this work,[1] but was subsequently shown to be erroneous,[2] and that the four teeth present in the skull are really milk-molars. In figure 3 of plate VII of this volume, a view of the inner aspect of these teeth is given, taken from a cast of the skull, the original being in the British Museum. It is on the authority of Falconer's reference of this skull to *R. palæindicus* that the milk-molars described above[3] are assigned to *R. sivalensis*, since they differ considerably from those in the skull under consideration. It will, perhaps, be simpler to show in what respect the latter differ from the milk-molars referred to *R. sivalensis*, than to describe them in detail.

The two sets of teeth belong to the two opposite sides of the skull, and the set referred to *R. palæindicus* contains the first milk-molar, which is wanting in the set referred to *R. sivalensis*. The second milk-molar (mm. 2) in the former is distinguished by having a very distinct median "costa" on the external surface, which does not occur in the corresponding tooth of *R. sivalensis;* the antero-external angle of the crown of the latter is more produced, and tends more towards

[1] Page 24. [2] Page 10. [3] Pl. VI, fig. 2.

the inner side than in the former. The third and fourth milk-molars are very similar in general outline, those of *R. palæindicus* being mainly distinguished from those of *R. sivalensis* by their superior size. The 'colles' in the former are, however, of more regularly conical form than in the latter, and the third milk-molar of *R. palæindicus* does not show the small 'combing-plate' uniting with the 'crochet,' which occurs in *R. sivalensis*. The above mentioned differences, except in the case of the second milk-molars, are but slight, and if taken by themselves, it might be doubtful if they would afford grounds for specific distinction. The following measurements show the dimensions of the figured specimens of the milk-molars of the two species. :—

	R. palæindicus.	*R. sivalensis.*
Length of first milk-molar	1·1	...
Width of „ „	0·89	...
Length of second „	1·65	1·6
Width of „ „	1·5	1·3
Length of third „	1·9	1·65
Width of „ „	1·85	1·6
Length of fourth „	2·2	1·87
Width of „ „	1·9	1·74

Mandible.—Specimens of the form of mandible which seems most probably to belong to this species are represented in plates LXXII, fig. 4, and LXXV, fig. 10 of the "Fauna Antiqua Sivalensis," under the name of *R. platyrhinus :* the reasons for assigning this form of mandible to the present species have been already given under the head of *R. sivalensis*. A smaller-sized drawing of one of the specimens alluded to above is given in the "Palæontological Memoirs."[1] This form of mandible very closely resembles the mandible of *R. indicus*, both in its dentition and shape. The symphysis is thicker, and less channel-shaped in the middle than in *R. sivalensis* and *R. javanicus*. The first premolar seems to have been shed at an early date.

The dimensions of the specimen figured in plate LXXII of the 'Fauna Antiqua Sivalensis' are as follows, in inches :—

Length of fragment	13·5
Breadth of symphysis	5·7
Length of „ inferiorly	7·0
Depth of jaw	4·7
Thickness of jaw	3·3
Length of four anterior molars.	7·4
Interval between incisive alveolus and molar series	3·1
Width between posterior molars	4·0
„ „ anterior „	3·4

The specimen figured in plate LXXV of the "Fauna Antiqua Sivalensis" is referred to in the description of the plates of that work as follows :—"Lower jaw, right side, and symphysis, containing very large outer, and small inner incisor of

[1] Vol. I, pl. XIV, fig. 4.

both sides, second, third, and fouth premolars, and first two true molars of right side." Its dimensions are as follows :—

Length of second premolar	0·7
„ of third „	1·4
„ of fourth „	1·65
„ of first true molar	1·46
„ of second „	2·0
Width of second premolar	0·45
„ of third „	0·85
„ of fourth „	1·1
„ of first true molar	1·05
„ of second „	1·2
Width between second premolars	3·5
„ „ outer margins of outer incisors	3·65
Oblique width of outer incisor	1·5
„ thickness „ „	0·7
Length of exserted portion	2·1

A very similar specimen of the symphysis, showing the alveoli of the median incisors, and the broken bases of the large external incisors, is in the collection of the Indian Museum. I am unacquainted with its history, though it is evidently from the Siwaliks.

Distribution.—Assuming that the specimens described above are all rightly referred to the present species, it would seem that its remains are found throughout the sub-Himalayan Siwaliks, from the Ganges to the Indus; its remains are, however, of very rare occurrence in the Punjab. In the first volume of this work (plate VI, fig. 8) a single lower molar from Sind is referred to this species. Seeing, however, that no identifiable upper molars of *R. palæindicus* have been obtained from that district, and taking into consideration the extreme uncertainty of any specific determination based upon the evidence of lower molars, it may be doubted whether that identification will hold. No remains of the species, as far as I am aware, have been determined from Perim Island or Burma.

Species 3. Rhinoceros platyrhinus, Falconer and Cautley.

History.—The name of this species, like the last, seems to have first appeared in the "Fauna Antiqua Sivalensis," where some imperfect skulls and teeth are figured, together with a form of mandible referred to the same species. No description of the species was ever given by the authors of that work. A note on a cranium in the British Museum by Dr. Falconer, which from its manifest inaccuracies was never intended for publication, is quoted in the "Palæontologica Memoirs,"[1] and will be again referred to below.

The specimens figured in the "Fauna Antiqua Sivalensis" (pl. LXXII) are an anterior and a posterior portion of a skull (figs. 1, 2), and a penultimate and last upper true molar (figs. 6, 7). On plate LXXV of the same work specimens of each of the above teeth are figured, of half the natural size (figs. 11, 12). The restored

[1] Vol. I., p. 157.

figure of the penultimate upper molar figured in the latter plate has been copied in the first volume of this work,[1] where a short notice of the species is also given. In the preface to the same volume[2] it has been shown that the attempted identification of this species with *R. sumatrensis* by the late Professor Brandt is founded upon false premises.

Cranium.—Besides the imperfect specimens of the cranium of this species figured in the "Fauna Antiqua Sivalensis," reference is made by Dr. Falconer in the note already cited to a nearly complete cranium, stated to have been obtained by Colonel Baker, the collector of so many Siwalik fossils, and now in the British Museum. This skull appears never to have been fully described or figured in a scientific work,[3] and I have accordingly given a profile view of it in this volume (pl. IX., fig. 2) in order to show its general form; this figure has been taken from a cast in the collection of the Indian Museum.

An examination of this cast shows that the skull is perfect, with the exception of the extremities of the premaxillæ, and that it belonged to a two-horned species, the rough surfaces for the attachment of the bases of two horns being most distinctly visible; the anterior horn must have been of very large size. The nasals are of great width and thickness, whence the specific name; this character is well shown in the specimen of which an upper view is given in figure 1 of plate LXXII of the "Fauna Antiqua Sivalensis." The supra-occipital region is produced into a high crest. The post-tympanic and the post-glenoidal processes of the squamosal are united below the external auditory meatus,—a character showing that the species has no direct affinity with *R. sumatrensis*. The premaxillæ are well developed, and perhaps carried a pair of incisors, though, if the mandible provisionally referred to this species really belongs to it, it may be doubted whether these teeth, if present, were persistent.[4]

In the following table some of the principal measurements of this skull are given in the first column, while in the second column are given some of the corresponding dimensions of the two imperfect specimens figured by Falconer and Cautley:—

Length from inferior border of foramen magnum to tip of premaxillæ (broken)	29·5	
Greatest width across zygomæ.	14·7	
Length of six molars	12·5	
Interval between outer surfaces of penultimate molars	8·4	
Height of occiput from inferior margin of foramen magnum	12·0	12·0
Width of „ above	8·6	8·4
„ of „ below	13·3	13·2
Height of foramen magnum	2·5	2·5
Width of „ „	2·1	2·0
Interval between external angles of occipital condyles	6·0	5·3
Extreme length of cranium, following curves of upper surface	33·0	
Greatest width at orbits.	10·4	10·6
Width of nasals	6·0	

[1] Pl. IV., fig. 4. [2] P. xi.

[3] This skull is figured on a small scale on page 28 of the "Ward series of casts of Fossils." Rochester, N. Y. 1866.

It is stated in the above mentioned note of Dr. Falconer that this species certainly had an upper incisor; no trace of such, however, is seen in the skull on which the note is based.

These measurements show that the three skulls have almost precisely the same dimensions; indeed, almost the only exception occurs in the occipital condyles, which appear smaller in one of Falconer's specimens; this, however, is very probably due to their having been injured.

Upper molars.—In plate VIII of this volume there is figured the upper molar dentition of the right side of the skull described above, drawn of two-thirds the natural size, from the cast in the Indian Museum. These teeth have already been shortly noticed on page 30 of the first volume of this work; but as they are now figured for the first time, they may be described somewhat more fully. In reference to these teeth the note of Falconer's, already referred to, published in the "Palæontological Memoirs" must be cited; it is as follows:—"The molars are in fine condition, six on either side. The last true molar is only just touched by wear. The last true molar is exactly like [that of] *R. hemitæchus*, in having a posterior basal funnel-shaped pit; while the penultimate and ante-penultimate true molars, and the penultimate and ante-penultimate premolars,[1] have each three distinct fossettes as in *Rhinoceros tichorhinus*. The vertical ridges of the outer side are very well pronounced in three valleys (*sic.*)"

This note gives a fair general idea of the characters of the teeth in question. The three anterior teeth (pm. 2, pm. 3, pm. 4) are shown to be premolars, from the fact of the last of them being less worn than the first true molar (m. 1). The first premolar (or ? milk-molar) has probably been broken off subsequently to the death of the animal, as its 'fangs' are still visible. The teeth belong to that form we have agreed to call the 'Indian type.' The 'dorsal' surface of each tooth is approximately straight, and carries two very distinct vertical ridges or 'costæ.' In the first true molar the hind-most of these ridges is much smaller than the other; in the second molar this 'costa' has nearly, and in the last quite, disappeared; there is no trace of a 'buttress' at the antero-external angle of the crown. The 'crochet' and the 'combing-plate' are united, and enclose between them an 'accessory fossette,' as is well exhibited in the first and second true molars (m 1. m 2). The last true molar of the left side shows at its posterior angle a minute in-folding of the enamel, representing the 'posterior valley' of the earlier teeth. A similar fold has already been shown to exist in the corresponding tooth of *R. sivalensis* and *R. javanicus*, and is, therefore, not, as one might be led to suppose from Dr. Falconer's note, peculiar to the present species and *R. leptorhinus* (*hemitæchus*).

The dimensions of the molars of this specimen are as follows:—

Length of second premolar	1·75
Width of „ „	2·1
Length of third „	2·05
Width of „ „	2·4
Length of fourth „	2·1
Width of „ „	2·5
Length of first true molar	2·4

[1] In the "Palæontological Memoirs" the word "milk-molars" occurs here; this is clearly a slip of the pen in Dr. Falconer's note-book, and has accordingly been altered.

Width of first true molar	3·1
Length of second „	2·7
Width of „ „	3·3
Length of third „	2·75
Width of „ „	2·9 (?)

The detached specimen of the last upper true molar figured, of half the natural size, in plate LXXII, fig. 7, of the "Fauna Antiqua Sivalensis," I have compared, by means of a cast, with the corresponding tooth in the set before us, and I find that the two are identical in form. The detached specimen seems rather the larger of the two, but this is, at all events partly, due to the other not being fully protruded. The length of the detached specimen is 3·2, its width 3·1,[1] and its height 3·1 inches. This tooth shows very clearly the pit at the posterior angle. The tooth drawn in figures 12 and 12a of plate LXXV of the "Fauna Antiqua Sivalensis" seems to be another view of the same specimen.

A specimen of the first or second upper true molar, represented in figure 6 of plate LXXII of the same work, is stated in the description of the plate to have a length of 2·3 and a width of 3·4 inches. The dimensions taken from the figure, however, would give a length of 3·6 and a width of about 3 inches. Similarly, the dimensions of the specimen drawn in figure 11 of plate LXXV of the same work would have a length of 4 and a width of 3 inches; this specimen is, however, restored, and the length is probably excessive. These two molars, if drawn to correct scale, would indicate that they belonged to a larger skull than the one above described. In general characters these teeth seem to agree with the true molars figured here; they, however, possess a more complex 'crochet,' which bifurcates at its extremity.

Comparisons.—Having now shortly noticed the main characters of the skull and upper molars of *R. platyrhinus*, we may endeavour to see with what other species of the genus it presents affinities. In this respect we shall of course have to deal only with two-horned species.

With *R. sumatrensis*, the skull of *R. platyrhinus* presents no affinities, since the teeth of the two are constructed on totally distinct plans, and, as we have already seen, differ in regard to the relations of their inferior squamosal processes. The miocene *R. schleiermacheri* is likewise distinguished by the form of its teeth, which are constructed after the Sumatran type.

Among the European bicorn species of the pliocene and pleistocene, in *R. etruscus*, *R. leptorhinus* (Owen), and *R. megarhinus*, the upper true molars, which seem to conform to what we have called the 'intermediate type,' do not usually present an 'accessory fossette' on the worn crown, the 'combing-plate' being either absent or, if present, not reaching the 'crochet.' *R. tichorhinus* agrees the most nearly of all these European species with *R. platyrhinus*, having two horns, and upper molars constructed on the same general plan, with an 'accessory fossette.' The cranium of the European form is, however, broadly distinguished by the presence

[1] This dimension is given by Falconer as 2·8 inches.