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INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

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FAUNA

OF THE

INDIAN FLUVIATILE DEPOSITS.

RHINOCEROS DECCANENSIS,

A new Species discovered near Gokak, Belgaum District, by R. B. FOOTE, F.G.S., Geological Survey of India.

In May 1871, while looking for sections in the bed of a small nullah, I came upon some fragments of fossil bones and teeth, and amongst them part of an upper molar of a Rhinoceros. I at once set to tracing out the source whence these bones might have been derived, and, after closely examining the banks of the nullah for a few dozen yards further up its course, found a row of large mammalian teeth exposed at a height of 3 feet above the bed of the nullah and fully 8 feet or more below the top of the bed of black clay which here forms the bank, and which black clay passes up into the typical regur of this neighbourhood. The spot at which this discovery was made lies about 3½ miles east north-east of Gokak (a talook town in the Belgaum District, well-known from the proximity of the great fall of the Gatparba River), and about ⅔ of a mile south south-east of the little village of Chickdowlee, immediately west of which the small nullah falls into the Gatparba River.

This small nullah* has cut deeply into and through the regur at that spot, and has formed a small cliff on the face of which the row of teeth abovementioned was exposed.

The rain-wash from the upper part of the little cliff had covered up everything, the teeth excepted, but on removing it carefully, I found the teeth belonged to the right ramus of the mandible of a Rhinoceros.

Beneath the rain-wash the black clay, though much broken up by sun-cracks, was hard, and the angular fragments were so closely wedged together that it required a good deal of time and trouble to remove those immediately surrounding the bones without disturbing the latter, which were not only extremely brittle, but also much comminuted *in situ* by the action of sun-cracks.

* The Chickdowlee nullah is a small stream rising in the hills to the north-west of Bunoochmurdee, and not as it is represented on the map, the extension of the large nullah flowing past Kelvee, which really falls into the great Mumdapoor nullah close to the village of Maldinee.

Had it been feasible I should very gladly have deferred the extraction of these bones for a day or two to do it more leisurely than was then possible; unfortunately the weather was very unsettled, numerous heavy thunderstorms had taken place within the previous week, and another was gathering at the time. Should a flood come down the nullah the greater part of the bones laid bare would certainly be swept away and lost. Then also the spot being between six and seven miles from my camp, it was impossible to keep watch over the fossil remains thus exposed, while the attention of several field labourers had been attracted by seeing me busily removing the soil with my hands, and they in their curiosity would, in all probability, have utterly ruined this valuable specimen had I left it unguarded. I decided, therefore, to take it at once as being the surest way of getting it as nearly as possible entire.

A few inches below the surface the clay became damp, but was still extremely tenacious, and it required great care and much patient labour to loosen the bones without entirely crushing them.

The position occupied by the head was suggestive of its having been drifted into its present resting-place, the heaviest part, the cranium, being undermost. The head had, however, not been entirely overturned, but originally rested on the right frontal bone and supraorbital ridge. The greater part of the right side of the head had been broken away by flood action undermining the bank. Unfortunately most of the bones thus detached and found loose in the nullah were too fragmentary to be joined together.

The left maxilla and left ramus of the mandible were in perfect apposition when freshly exposed, but the left side of the head had suffered severely prior to its entombment, as the frontal and nasal bones were missing.

The position of the left ramus in apposition to the maxilla offers a strong indication of the head, though much mutilated, not having been entirely deprived of its external covering of flesh at the time it was buried in the black clay.

No indications of any bones but such as belonged to the head were met with *in situ*, though the bank was excavated to some little depth after removing all that remained of the cranium.

Among the bones found loose in the bed of the nullah only one or two fragments appear to belong to the body of the animal, and they are somewhat doubtful.

The bones found imbedded were—

1.—The mandible, nearly perfect.
2.—The left maxilla with jugal and lachrymal bones attached.
3.—The squamosal bone with meatus auditorius and post-tympanic process of the left side.
4.—Part of right frontal bone.
5.—Hyoid bones?
6.—Pterygoid bone (right side?)

Lying loose in the sandy bed of the nullahs were parts of the right maxilla, fragments of teeth, and two or three bones too fragmentary to be determined.

Bones very thickly encrusted with two kinds of kunkur.

When found the bones were largely covered with minutely botryoidal calcareous concretions, forming an extremely hard and dense crust irregularly distributed over the surface, in some places in large and thick patches, at others in small wart-like excrescences. From the brittle condition of the bones these were very difficult to remove without destroying the underlying surface of the bones. Many had to be gently rasped away—an operation requiring much time and patience, because of the hardness of the material.

Besides this botryoidal encrustation the whole surface of nearly every bone was covered by a thinner crust of a more earthy material less hard than the former. The less dense parts of this crust assimilated to common earthy kunkur, but some of the dense parts of it, which showed an arrangement in vermicular masses, though less hard, were extremely tough and fully as difficult to remove as the other form of encrustation. The removal of these crusts was, however, quite essential, as they completely hid and altered the true shape of many parts of the bones. The encrustation was by no means confined to the surface—it had penetrated most of the numerous fissures due to the expansion and contraction of the surrounding clay. These intrusions of kunkur had in many cases, particularly where they affected the teeth, given rise to total deformity of the parts by wedging them asunder, sometimes to the extent of half an inch or more. Part of the surface of many of the teeth has been eaten into as if by a kanker, by the calcareous crust resting on it, forming small shallow pits on the surface of the enamel.

The degree of alteration the bones have undergone is very various in different parts; especially is this the case with regard to the teeth, in many of which part of the enamel is perfectly preserved, while closely adjacent parts have been greatly changed and have lost all lustre and become quite mealy in texture. Excepting external discoloration from contact with surrounding soil, the bones are but slightly altered from their natural color, though a good deal of calcareous matter became infiltrated in their cancellar tissue. The enamel of the upper molars is rather browner in color than that of the lower ones. The dentine of all the broken teeth is a good deal stained along the minute capillary tubules of a deep black, apparently due to the presence of oxide of manganese. The cavities in the fangs of the teeth left by the decay of the pulp are mostly lined with acicular crystals of arragonite. The dentine was found to be traversed by innumerable minute cracks, rendering the mass extremely brittle, especially near the base of the crowns and in the fangs. Owing to this many of the teeth fell to pieces, and had to be built up by fitting piece to piece—a very long and tedious task from the great number of tiny fragments that had to be dealt with. But for the fact that the manganese stains of the dentine tubules above alluded to often formed patterns on the broken surfaces, the building up process of the dentinous parts would have been simply impossible.

Some change in the form of some of the bones has been caused by the pressure of the mass they were imbedded in. The parts principally affected by such pressure are the mandibles, the jugal arch, and the supradental portion of the left

maxilla. The mandible is materially distorted, the right ramus especially having been forced over to the left side very considerably, and the symphysis having been twisted so that the left side of the symphysial prolongation is fully half an inch higher in level than the right. The right ramus is also rather broken at the lower edge about the middle of its length.

The upper and outer part of the left maxilla above the molar series is much crushed out of shape, so much so that the jugal arch, instead of being parallel to the side of the skull, has been turned over outwards, so that at present it has a position nearly at right angles to its normal one.

The plane of the dental series of the maxilla has also been considerably more curved than normal, the result being that the molars and premolars, instead of being in close apposition to each other as in all other species of Rhinoceros, are divided by spaces. This is especially observable between *premolars* 2 and 3 and *molars* 1 and 2 and 2 and 3. The bones appear to have been in a rather soft state when thus affected, else they must have been far more extensively fractured.

On comparison with all the other described species of Rhinoceros, both living and fossil, the head discovered at Chickdowlee shows such marked differences that it cannot be assigned to any one of them, and deserves, therefore, to be considered as a distinct and hitherto undescribed species. As such I propose to call it *Rh. Deccanensis;* and as the region in which it was found belongs distinctly to the Deccan in the older and fuller meaning of the name, and most of the other Asiatic Rhinoceroses, both recent and fossil, have been distinguished by geographical specific names, the one now proposed appears quite suitable.

The head only of *Rh. Deccanensis* being known, comparisons could only be instituted with corresponding parts of specimens of other species. Eight distinct points of character came specially under comparison, and they were in order of importance—

1.—The proportional height of the crowns of the teeth.
2.—The form of the symphysis of the mandible.
3.—The presence or absence of incisor teeth and their size.
4.—The special structure of the upper molar series.
5.—The form of the bones of the periotic region.
6.—The form and proportions of the zygomatic arch.
7.—The relative size as compared with that of other species.
8.—The deciduous character of premolar 1.

In carrying out the comparison of the remains of this Rhinoceros with those of other species, I have followed the methods adopted by the late Dr. Falconer and by Mr. Boyd Dawkins, F. R. S.,* and for the descriptive portion and plates have adopted the terms (with two exceptions) and indicative letters employed by the latter palæontologist in his several very able papers on the dentition of the Rhinocerotes found fossil in Great Britain.

* See Falconer's Palæontological Memoirs and Mr. Boyd Dawkins' papers in the Natural History Review, 1863 and 1864, and Quarterly Journal of the Geological Society, Vol. XXIII, 1867, and Vol. XXIV, 1868.

With regard to living species I have followed the latest enumeration given by Dr. J. E. Grey in the "Annals and Magazine of Natural History"* in continuation of the list published in his catalogue of the Pachydermata in the British Museum.

Unfortunately some species included among those are founded on external characters only, *e. g.*, *Rh. Oscellii* and *Rh. Crossii*, and with such, of course, comparisons were impossible.

My specimen was compared with all known published descriptions and with the fossil and recent specimens in the British Museum, the Royal College of Surgeons, London, the Jardin des Plantes, Paris, the Museum of the K. K. Geol. Reichs Anstalt, Vienna, the Imperial Museum, Calcutta, the Madras Museum, and last, but not least, the Geological Museum, Calcutta. And here I would express my sincere thanks to Mr. Henry Woodward, F. R. S., to Mr. Davis of the Palæontological Department of the British Museum, and to Professor A. Gaudry of the Jardin des Plantes, for the true courtesy with which they gave me every assistance in their power in carrying out such comparison with the specimens in their custody.

The head of *Rh. Deccanensis* indicates a smaller and slighter animal than *Rh. Indicus*, but one larger in all probability than any of the other living Asiatic species.

The head is that of a young adult animal whose permanent dentition is represented by the formula $I\frac{0}{0}$? $C\frac{0}{0}$, P. M. $\frac{2\text{-}3\text{-}4}{2\text{-}3\text{-}4}$, M. $\frac{1\text{-}2\text{-}3}{1\text{-}2\text{-}3}$.

Dental formula.

The teeth, which were not furnished with a cement layer, are not much worn down by use; indeed, the last molars in each jaw had only just begun to show signs of wear. The animal belonged very markedly to the hypsodont section of the family.

The incisors are wanting in the mandible, and from the rather broken condition of the incisive border of the symphysial portion, it is difficult to be quite positive whether alveoli had ever been developed there or not. The incisors, if developed there, were extremely small and quite rudimentary.

The premaxillary bones are unfortunately wanting; hence the presence or absence of incisors in the upper jaw cannot be determined, but the probability is that they were extremely small or wanting. Two fragments of bone were found loose, which present some resemblance to the anterior extremities of pre-maxillary bones in other species, and, if they should really be such, their appearance certainly disfavors the idea that the animal possessed upper incisors.

Professor Owen has pointed out that the development of the horns of the *Rhinocerotes* is in the inverse proportion to the magnitude of the incisors. If this law held good in *Rh. Deccanensis*, it must have had a very large horn or pair of horns.† Unfortunately, however, the nasal bones were not found; so, this point remains for the present undecided.

* Annals and Magazine of Natural History, 4th Series, Vol. XI, p. 356.

† Owen's Comparative Anatomy of Vertebrata, Vol. III, p. 356.

The mandible.

The anterior or symphysial part of the mandible is prolonged beyond the premolars in a narrow beak-like projection unlike in form or proportion to any species hitherto described and figured. A correct idea of its form will be obtained by referring to figures 3 and 4, Plate II. The peculiarity of this symphysial prolongation consists in its narrowness and in the sudden diminution in width in front of the permanent premolars. *Rh. Etruscus*, Falconer, which of fossil species most resembles it, shows a less sudden constriction, if the term may be used, of the extension of the symphysis in front of *premolar* 2, and the extension is moreover wider in proportion. In *Rh. niger*, Gray, the symphysis is narrow, but longer than in the Deccan species, and ends in a sharp toothless incisive border. Many species of Rhinoceros, both recent and fossil, show this extension of the symphysis, but instead of its being narrow throughout its length and constricted immediately in front of the premolars, it is wide at first, then narrows, and before reaching the incisive border spreads out again in a spatulate form. In many species large or moderate sized incisors project from the anterior border. In *Rh. Deccanensis* the rather broken condition of the incisive border (*i. b.* fig. 4, Pl. II) renders it a little doubtful whether incisors had been developed there or not. If the small and irregular cavities observable in that situation were true alveoli, and probably they were so, the incisors must have been very small and rudimentary, as has already been mentioned above. There is no trace of them left, so they had probably been shed while the animal was alive.

The incisors.

There are no indications of large mentary foramina like those so strongly developed in *Rh. Etruscus*.

As already mentioned (*ante*, p. 5) the symphysis has been somewhat twisted by pressure, and the right ramus has been forced over considerably towards the left one, and the central part of the lower edge rather broken. The left ramus appears to be unaffected by the pressure, but has lost the coronoid process. The condyle is relatively small, the transverse length of the articular surface being only 3 inches, while the same part in an otherwise much smaller mandible of *Rh. Sondaicus** measured 3¼ inches across. The curve of the ascending part of the ramus commences just below the median groove of *premolar* 3. The height of the ascending part of the ramus is 9·15 inches to the summit of the condyle, measured vertically from the surface the mandible rested on, or 11·75 inches, measured with a tape along the posterior edge from the condyle to the angle. From the angle to the incisive border, measured along the under side of the ramus, is a distance of 19 inches. The left ramus only was measured, being much the more perfectly preserved. The posterior edge of the ascending ramus rises almost straight, and is not notched below the condyle as in *Rh. Sondaicus* and various other species.

The ascending portion of the ramus.

* In the collection of the Imperial Museum, Calcutta.

The lower molar series.

The lower molar series is represented by six normally-shaped tall crowned teeth—three premolars and three molars. Of these premolar 2, on either side, is perfect, except that the posterior wall is rather broken.

Premolar 3 is imperfect on both sides, the inner being broken away. Premolar 4 is altogether wanting in the right ramus and wants the inner wall in the left ramus.

Of the true molars in the right ramus, molar 1 is rather imperfect; molar 2 and molar 3 are perfect in the crowns; these are figured in Plate III, figs. 2 and 3. It will be observed that the posterior collis of premolar 3 had only lately begun to come into wear. The corresponding teeth in the left ramus are less well preserved. The lower molars of *Rh. Deccanensis* are not specialized, and offer no strikingly characteristic differences from many other species. The guard is but slightly developed on the anterior and posterior walls, and does not show on either the inner or outer walls in the lower molars. Molar 1 of the left side has been forced upwards and backwards by an intrusion of the encrusting matter, as shown in fig. 3, Plate II.

The annexed measurements of the lower molars may be interesting for purposes of comparison—they are as exact as the imperfect state of the specimen admitted of their being. They were made in the following directions, after Mr. Boyd Dawkins's system, at the base of the crowns:—

1.—Antero posterior, along outside of crown.
2.—Antero transverse, across anterior collis.
3.—Postero transverse, across posterior collis.

Tooth.	*Side.*	1.	2.	3.
Premolar 2	Right	1" 3‴	6¼‴	...
Ditto 3	Left	1" 3‴	...	...
Ditto 4	do.	1" 7‴	...	...
Molar 1	Right	1" 8‴	1"2¼‴	1" 4‴
Ditto 2	do.	1"11‴	1"8‴	1" 3½‴
Ditto 3	do.	2" 1‴	1"3‴	1" 2¼‴

The length of either row of lower molars on the right side is 11⅛ inches, measured along the outer bases of the crowns.

Before passing on to the description of the much more complex upper molar series, it will be better to give a key to the indicative letters used in the plates, and which, as already mentioned, agree with those employed by Mr. Boyd Dawkins in his several memoirs. As both upper and lower molars are recognized to be formed on the same plan, though differing very greatly in the degree to which that plan was developed, the letters apply to the homologous parts in both series. The teeth are compared to a hill sub-divided by two valleys running down from the main ridge or outer wall of the tooth. Besides the subordinate hills thus formed, there are certain processes jutting from the walls of these hills into the area of the valleys, certain prominent ridges on the outer wall, certain remarkable ledges of enamel running round the sides of the walls, and certain grooves dividing the outer wall into areas, which all have to be accounted for, as their form, or presence, or absence are of great and often specific import. The comparison to a hill only

holds good to a certain extent, but it would be very difficult to find any natural object with which a better comparison could be instituted, and it has been adopted in part by so many eminent palæontologists that it is better to carry it on than introduce another, though a much better one might be found if a fortification, such as a small Indian fort or mediæval castle, were the object adopted for the comparison. The following list shows the principal parts of the teeth and the letters they are indicated by :—

- *a. Anterior valley.‡
- *b. Posterior valley.‖
- *c. Accessory valley.
- *d. Anterior collis.§
- *e. Median collis.¶
- *f. Posterior collis.
- g. Anterior process=crista.
- h1. Median process.
- h2. Posterior process=crochet=uncus.

} "Combing plates" of Boyd Dawkins.

- i. Median groove on outer wall of tooth.
- *k. Costæ on the outer wall.
- l. Outer wall (divided by "i" into "m" and "n"). "External lamina" of Boyd Dawkins.†
- m. Anterior area.
- n. Posterior area.
- o. Guard=cingulum=bourrelet=wulst.
- p. Opening to anterior valley or "pass."

The maxilla and upper molar series.

The left maxilla was found *in situ* with its six teeth, and is figured in Plate I. Of the right maxilla only fragments were found loose in the bed of the nullah, and from these the teeth were missing, but fragments of some teeth were also found loose. The upper molars were unfortunately more affected by decay (whatever may have been the cause), and more penetrated by the veins of encrusting matter, while the great depth of the valleys rendered them more fragile than the lower molars. Of the teeth in the left maxilla *premolar* 2 and *molar* 2 are much broken. *Molar* 1 and *molar* 3 are also considerably damaged: still enough remains to give a fair idea of this most characteristic part of the whole dentition. In both *premolar* 2 and *molar* 2 the outer wall is wanting.

The premolars of *Rh. Deccanensis* are specialized by the very great development of the ledge of enamel, known as the cingulum or guard (Boyd Dawkins), which occurs mostly on the anterior and inner walls of the teeth, and which is well shown in both figs. 1 and 2 of Plate I. I think I am right in saying that in no other species is this peculiar appendage of the premolars so strongly developed, and in this respect it resembles some of the European miocene species. Premolar 1 was deciduous and probably a very small tooth, as no sign of it can be made out on the edge of the maxilla. In premolar 2 a small pit,* fig. 1, Plate I, shows in the enamel ledge or

* The equivalent terms in Latin are employed by Brandt (*Rh. tichorhinus*, Mem., Acad. St. Peter, 6e ser., tom. VII.)

‡ Vallon oblique, in upper molars, Cuvier.

‖ Ecorchure aû bord posterieur, Cuvier; Fossette posterieur, Blainville.

§ Colline seconde, of upper molars, Cuvier.

¶ "La troisième colline," of upper molar, "le bord posterieur de la dent." Cuvier.

† Collis externus, Brandt. "Colline première qui suit exactement le bord." Cuvier.

guard on the anterior wall of the tooth; this is the only part of the building up of the teeth that I feel a shade of doubt about, because such a pit does not seem to be known in other species; the fragmentary parts, however, fitted most perfectly together. The corresponding portion of the right jaw premolar, is unfortunately unknown. This tooth is a good deal more worn than premolar 3 and 4, and the pass *p*, leading from the inner wall of the tooth to the anterior valley, is almost obliterated by wear. The edge of posterior wall of the tooth has also been so much worn that the posterior collis is separated from the posterior valley by a belt-like surface of dentine. In premolar 3, on the contrary, much less wear has taken place, and the three colles stand up distinctly. The guard commences on the anterior wall, at about one-third of the length of the wall from the anterior angle of the outer wall, and runs all round the inner wall till it merges in the posterior collis. The pass *p* dividing the anterior and median colles is deep and sharply defined. The external side of the anterior valley (*i. e.*, the side next the exterior wall of the tooth) is rather broken round the top. A spur of enamel projects from the median collis very nearly across the anterior valley, and shows that a very strongly marked crochet characterized this tooth. The posterior valley is rather oval in shape, imperfectly so however, as the curve on the posterior side of the major axis is much greater than that on the anterior side of the axis, which is parallel with the axis of the median collis. The posterior wall of the tooth descends but little from the posterior collis, and thus shows signs of wear, and also gives the posterior valley a decidedly pit-like appearance quite different from the bay-like appearance it presents in many other species, owing to the posterior wall of the tooth being deeply notched by the posterior valley. This character belongs also to the posterior valleys of premolar 2 and 4. The outer wall of premolar 3 is characterized by the anterior angle or costa k_1, forming an acute angle; k_2 the second costa is well developed, but the whole wall of the tooth is remarkable for its flatness.

Premolar 4 is, on the whole, very little different from premolar 3, though of considerably larger size. The chief difference lies in the larger proportional size of the anterior collis, which is taller and more bulging a little below the present surface of mastication. Premolar 4 is perhaps a little less worn down. The anterior angle of premolar 4 is also rather more acute. The appearance of greater height in the anterior collis of premolar 4 as compared with *premolar* 3 is in measure due to the lower position occupied by the guard on the anterior half of the inner wall of the tooth. The central part of the masticatory surface is rather broken, but there is a well marked fold of enamel projecting from the median collis, h_2, showing that a large crochet would be present were the tooth unbroken. The outer wall of the tooth is, like that of premolar 3, remarkable for its flatness, which greatly exceeds that of all other species I have been able to compare it with. This character will be apparent from a comparison of fig. 1 in Plates I and II.

The true molars, as already stated, are unfortunately less well preserved, but enough remains to recognize many of their chief characteristics. The true molars

will be seen not to show the great development of guard which is so conspicuous in the premolars. The guards in both molars is confined to the anterior wall of the tooth, and there it occupies a much smaller space, extending less than half the length of the wall from the inner anterior angle. Moreover, in molar 1 its position is very different, as it lies very high, nearly level indeed with the crown surface of the anterior collis, upon which it rather encroaches and makes a small shelf, harp-shaped in plan, instead of a jutting ledge. In molar 2 the guard forms a wide ledge, sloping upward from the inner anterior angle nearly to the middle of the anterior; unlike *m*, 1, however, the guard springs from a point about half way down the side of the anterior collis. The anterior collis of the true molars is of much larger proportions than in the premolars, as compared with the whole size of the teeth, being very broad and stout, especially in molar 1, where it forms much more than half of the inner side of the tooth. By this increase of size in the anterior collis the anterior valley is greatly narrowed, and the pass no longer occupies a median position, and has become very narrow and much deeper than in the premolars. The crochet h_2 is very large, and all but touches the posterior wall of the anterior collis. The outer wall of the anterior valley also forms a projecting fold of enamel (h_1, fig. 1, Plate I), which projects forward and inward. The posterior valley is unfortunately wanting, that part of the tooth being broken away, but judging from the fragment of *molar* 1 of the right jaw, which was found loose in the nullah-bed, the posterior valley most likely resembled that of premolar 4. This fragment, which is figured in Plate II, fig. 2, shows a saddle-like slope descending from the posterior collis *f* into the posterior valley. On the outer wall of the tooth it will be seen that the anterior angle is less prominent than in premolar 4; the hinder part of the outer wall is much broken, but not too much to show the peculiar flatness described as characteristic of the premolars. The figure of the fragment of molar 1 of the right jaw above referred, was given to show the great depth of the anterior valley, which, as before remarked, is one of the special characters of the dentition of *Rh. Deccanensis*.

Molar 2, the largest of all the series, is unfortunately the least perfect, the anterior collis only remaining in tolerable preservation. The general character of this tooth can, however, be traced in plan. The form of the guard has been referred to already in the description of molar 1. The anterior collis (*d*) differs less from the analogous parts in premolar 3 and 4 than does that of molar 1. It is less massive in form, and does not encroach so much on the anterior valley. The median collis is, on the contrary, actually and proportionately stouter than in molar 1. The pass (*p*) is a shade less narrow, but would appear to have been quite as deep proportionately in the unbroken tooth. The two crochets h_1 and h_2 were, judging by the remaining lower parts (regarding the tooth as in an inverted position,) much stouter than in molar 1, but the angle at which they rise seems to indicate that they projected less into the area of the valley.

The posterior valley is smaller at the same depth than that of premolar 4, and forms a long ellipse in plan; the major axis of the ellipse being nearly parallel to

the line of the outer wall of the tooth, and far from parallel to the axis of the median collis (*e*). The outer wall is entirely wanting, and so in fact is the masticatory surface of the entire tooth, that of the anterior collis only excepted.

Molar 3, though unhappily also much damaged, is more perfect than molar 2, and exhibits the trihedral form seen in most of the *Rhinocerotes*. It had undergone but little wear at the time when its owner was entombed. This is proved by the great height of the anterior collis.

The guard occurs only on the anterior walls very much below the crown of the collis. As in the other teeth the anterior valley is extremely deep, and was intruded into a very stout and long crochet (h_2), the base of which is seen at some depth. The posterior collis (*f*) is represented by a little spur-like cusp (shown in figs. 1 and 2, Plate I) low down on the posterior angle of the tooth.

The teeth of both jaws are furnished with long fangs, but they were not exposed sufficiently in any case to observe any peculiarities they may possibly possess.

The thickness of the enamel varies greatly in different parts of the teeth, being thickest in the walls of the median collis and thinnest in the walls of the crochets and in the exterior walls of the anterior valleys. In the lower molars it was thickest in the outer wall, and thinnest in the walls of the anterior collis.

The length of the upper molar series measured along the edge of the crowns from the posterior angle of *molar* 3 to the anterior angle of *premolar* 2 is 10·9 inches. As before mentioned (page 6), the supradental part of the left maxillary bone is much affected by crushing, so much so that when the malar bone is placed in apposition its plane lies almost at a right angle to its normal position. The distortion is greatest above the true molars. On account of this distortion the zygomatic arch has not been figured. It forms a strong broad band connecting the maxilla with the squamosal bone by a rather flat arch. The zygomatic process is unfortunately rather broken at its base, and the connection of the zygoma with the squamosal bone therefore incomplete.

The lachrymal bone shows a well marked post-orbital projection, and the malar bone has a distinct protuberance on its upper edge opposite to the position the post-orbital process would occupy if developed in this genus.

The squamosal bone is figured in Plate III, fig. 1, in order to show the peculiar form of the groove between the post-glenoid and post-tympanic processes in which the meatus auditorius is situated, as the form of this part of the cranium in *Rh. Deccanensis* differs very greatly from many other species, as will be shown further on in enumerating the points of difference between this and other allied species.

The area between the two processes is wide and shallow at its upper part, rather deeper below the opening of the meatus; in plan it is very nearly rhomboidal. The post-glenoid process terminates in a lobe about two-thirds of an inch below its inferior junction with the post-tympanic. The latter process is greatly

thickened and protuberant near its centre. The meatus occupies the lower half of the area above defined, and is large.

The hinder edge of this mass of bone would appear to be part of the supra-occipital, possibly of the ex-occipital also, and if so, it proves that the occiput was protuberant, not concave as in some species.

The other bones found imbedded were part of the right frontal bone, the right pterygoid and two slim bones which lay between the rami of the mandible, and have a resemblance to hyoid bones, but are not sufficiently well preserved to be identified with certainty.

Rh. Deccanensis is distinguished specifically from all the brachydont miocene species, and also from *Rh. Etruscus*, by its strongly marked hypsodont character and by the non-persistency of the first premolar tooth, but it is allied to many of them by the strong development of the guard in the molar series.

It is allied to the African forms of Rhinoceros by the rudimentary character (or possible absence) of the incisors, but separated by the greatly elongated symphysis of the mandibles and the great development of the guard in the premolars.

There remain then the three European pleistocene species—*megarhinus*, *hemitœchus*, and *tichorhinus*—one hypsodont miocene form from Pikermi in Greece, the pliocene American form *Rh. crassus*, Leidy, and the living and fossil Asiatic species with which to compare it.

Mr. Boyd Dawkins, F. R. S., in his very interesting paper on *Rh. Etruscus*,* when speaking of the division of the *Rhinocerotes* into two classes by the relative heights of the unworn crowns of their teeth, reckons all the known living species to the hypsodont division, as also all the Asiatic fossil species. It appears to me, however, that three of the more recently established living Asiatic species—*Rh. Floweri*, Gray, *Rh. stenocephalus*, Gray, and *Rh. (ceratorhinus) niger*, Gray—show such low crowned teeth that they approach more closely to the brachydont type, and that the conclusion that this type had ceased must be modified.

Taking the different species to be compared seriatim, we find that the Deccan species differs from *Rh. megarhinus* by the narrowness of the extended symphysis, which is broad and spatulate in the latter; by the great development of the guard, which is slight in *megarhinus*; by the greater development of (k_2) the second costa on the outer wall; by the different form of the posterior valley, and by the absence of the deep notch on the posterior edge of the rami of the mandible immediately below the condyle.

Rh. megarhinus.

From *Rh. hemitœchus* *Rh. Deccanensis* differs by the absence of the thick layer of cement found in the molars of the former; also by the different character of the molar series, for in *Rh. hemitœchus* the anterior and median colles are very narrow and compressed, and the posterior collis very low and small. In *Deccanensis*, on the contrary, the

Rh. hemitœchus.

* Quarterly Journal, Geol. Soc., Vol. XXIV, 1868, p. 214.

anterior and median colles are stout and broad, and the posterior collis, though small, attains the same level as the median.

Rh. tichorhinus.

From *Rh. tichorhinus* we must separate *Deccanensis*, because of its not possessing the thick layer of cement on the molars; because of the absence of the accessary valley "c," and because the grinding surfaces of the molars are not flat as in *tichorhinus*, but deeply excavated.

Rh. from Pikermi.

From the hypsodont miocene species from Pikermi, near Athens, described, but not named, by Professor A. Gaudry in his splendid work—"Animaux Fossiles et Geologie de l'Attique"—*Rh. Deccanensis* differs by its greatly smaller size; by the position of the guard, which is much higher up the side of the tooth than it is in the Pikermi species. In the latter the posterior wall of the tooth in *premolar* 3, *molar* 1, and *molar* 2 is deeply notched by the posterior valley, which is not the case in *Rh. Deccanensis*.

Rh. crassus.

The pliocene American species, *Rh. crassus*, Leidy, possesses large incisors in the lower jaw, with a broad spatulate symphysis strongly resembling *Rh. Indicus*, while the upper molar series is characterized by the presence of four valleys (anterior, two median, and posterior). Its specific diversity from *Rh. Deccanensis* is, therefore, abundantly clear.

The rudimentary character (or possible absence) of the incisors at once separates *Rh. Deccanensis* from *Rh. Indicus*, *Sondaicus*, *Sumatranus*, *nasalis*, Gray, and *stenocephalus*, Gray, but there are other distinctions also which will be pointed out separately. If I am right in my conclusion that the brachydont type is not yet extinct, *Rh. Deccanensis* would on that ground alone be separated from the remaining living Asiatic species (of which the bones are known), namely, *Rh. Flowcri*, Gray, and *Rh.* (*ceratorhinus*) *niger*, Gray, as also from the fossil species *Rh. Sinensis*, Owen; but there are other distinctions also which require their specific separation.

Rh. Indicus.

Taking each species by itself, it will be seen that *Rh. Deccanensis* differs from *Rh. Indicus* in having only rudimentary (or no) incisors, instead of extremely large ones; also by the greater development of the guard, by the much greater relative depth of the valleys, and the much greater flatness of the outer walls of the upper molars. The rugosities at the angle of the mandible, so conspicuous in *Rh. Indicus*, are hardly at all developed in *Rh. Deccanensis*, which likewise has not the deep notch on the posterior edge of each ramus below the condyle. The broad spatulate extension of the symphysis is quite unlike the narrow beak-like form it assumes in *Rh. Deccanensis*. Then the auditory fossa on the squamosal bone is quite unlike, being broadly rhomboidal in shape in *Deccanensis* and much taller and narrower in *Rh. Indicus*. In size *Rh. Deccanensis* was certainly quite one-fourth less than the average *Rh. Indicus*, if the size of the head offers a sufficient datum to go upon in

making such an estimate. Many other minor but well marked differences might be adduced, but the above seem sufficient.

Rh. Sondaicus.

From *Rh. Sondaicus* *Rh. Deccanensis* is separated by the character of its incisors, which are very good-sized in the former. In *Sondaicus* the guard is only very moderately developed in the premolars, while the teeth are much less high crowned and show relatively much shallower valleys and very tumid outer walls instead of nearly flat ones like those of *Rh. Deccanensis*.

Rh. Sumatranus.

In *Rh. Sumatranus* we find large strong incisors, a very slight development of the guard in the premolars, and a totally different form of the auditory fossa of the squamosal bone, whereby to distinguish it specifically from the Deccan species. In *Sumatranus*, owing to the very great curvature of the post-glenoid process, the apex of the fossa lies far behind the opening of the meatus auditorius, whereas in *Deccanensis* it is very nearly vertically over it. The posterior edges of the mandible are deeply notched below the condyle in *Sumatranus*. The zygoma also is much stouter, more curved in the vertical plane, and shows a crescent-shaped excavation on its upper edge just behind the post-orbital angle—all characters absent from *Rh. Deccanensis*.

Rh. nasalis.

The difference between *Rh. Deccanensis* and *Rh. nasalis*, Gray, consists in the possession by the latter species of good-sized incisors and a persistent first premolar. In *nasalis* the guard is but very slightly developed, and the rami are very much slighter than in *Deccanensis*.

Rh. Floweri.

In *Rh. Floweri*, Gray, the teeth are decidedly less tall-crowned than in *Rh. Deccanensis*. Premolar 1 is persistent instead of deciduous, and the molar series is characterized by a very prominent development of the second costa (k_2) of the outer wall. The zygoma also is much more arched laterally than in the Deccan species, which was a considerably larger animal than *Rh. Floweri*.

Rh. niger.

A comparison of *Rh. Deccanensis* with *Rh. niger*, Gray, shows that the latter has an extended mandibular symphysis, longer in proportion than that of the former, which terminates in a narrow incisive edge not furnished with teeth and not showing any signs of alveoli. *Rh. Deccanensis* shows several small cavities on the incisive border, supposed to be alveoli, from which the existence of rudimentary (though very likely deciduous) incisors must be inferred. The mandible of *Rh. niger* is much slighter, and the ascent of the ramus does not begin till well behind molar 3, whereas in *Rh. Deccanensis* it commences at the middle of the outer wall of molar 3. The ascending portion of the ramus of *Rh. niger* is also much slighter, and is incurved along the posterior edge below the condyle instead of straight as in *Deccanensis*. The zygoma shows a well marked lunate excavation on its upper edge not found in my new species. The meatus auditorius of *Rh. niger* is narrow and leans slightly forward, and is altogether unlike that of *Rh. Deccanensis*.

It has already been shown that *Rh. Deccanensis* agrees with the fossil Indian Rhinoceroses hitherto described in being hypsodont. It differs, however, in many points which will now be enumerated.

Rh. Sivalensis.

Rh. Sivalensis, Falconer, does not show the guard on the inner side of the upper premolars, which is so marked a feature in *Deccanensis*, and both the anterior and posterior valleys are relatively much shallower. The frontal bones of *Sivalensis* are deeply incurved: in *Rh. Deccanensis* they are flat, or but very triflingly incurved. The zygoma of *Rh. Sivalensis* is not so wide in proportion to its length as that of the Deccan species.

Rh. Perimensis.

In *Rh. Perimensis*, Falconer, the guard is also absent from the upper premolars. The anterior and median colles are much more oblique and much narrower, and the anterior valleys are much shallower and pointed at their anterior extremities, while the posterior form deep notches on the posterior wall—all points of marked difference from *Rh. Deccanensis*. The ascent of the rami of the mandible begins well behind molar 3 in *Rh. Perimensis*, and not at the median groove on the outer wall of that tooth as in *Deccanensis*. *Rh. Perimensis* was a larger animal than *Deccanensis*.

Rh. Palæindicus.

The most striking difference between *Rh. Palæindicus*, Falconer, and *Rh. Deccanensis* lies in the form of the auditory fossa, which in the latter forms a broad, shallow, roughly rhomboidal area, with the meatus opening into the lower half. The meatus itself is somewhat triangular in form. In *Palæindicus* the fossa is triangular and very small, with a circular meatus opening centrically and filling nearly the whole space between the post-glenoid and post-tympanic processes. *Rh. Palæindicus* had also good-sized lower incisors, and the prolonged symphysis, although slightly constricted in front of the premolars, expands further forward and becomes spatulate. The upper premolars did not possess a guard, and the valleys of the whole molar series are much shallower than in *Rh. Deccanensis*. The zygoma is more slender than in *Rh. Deccanensis*.

Rh. platyrhinus.

Rh. platyrhinus, Falconer, differs from *Rh. Deccanensis* in possessing large incisors and a broad spatulate symphysis. The auditory fossa is also much narrower, and the zygoma much narrower and more slender. *Rh. platyrhinus* does not show any ant-orbital wart-like rugosities as does *Rh. Deccanensis*. The anterior and median colles in the molar series in *Rh. platyrhinus* are more oblique, and the walls of the valleys much more complicated by foldings of the enamel.

Rh. Sinensis.

Rh. Sinensis, Owen, is very distinct from *Rh. Deccanensis*. It is much smaller and distinctly brachydont; the upper premolars do not possess a guard; the valleys are very shallow, and the crochet a mere wave in the enamel wall of the median collis. Molar 3 is quadrate, rather than trihedral, in plan, and the enamel walls of all the teeth are relatively very much thicker than in *Deccanensis*.

At least three species of Rhinoceros appear to have been found fossil in Burmah, but have not yet been named and determined: of these one was described and figured by Mr. Clift in the Transactions of the Geological Society, 2nd Series, Vol. II, "but not named:" the other two are represented by specimens in the Geological Museum, Calcutta. *Rh. Deccanensis* differs specifically from all three. Of the animal described by Mr. Clift, two much worn left upper molars are there shown, in both of which the posterior valleys form deep notches in the posterior wall—a character not seen in *Deccanensis*. The crochets also are mere waves in the enamel walls of the median collis. The anterior outer angle of the teeth is less acute and less projecting than in *Deccanensis*. K_2, the second costa on the outer wall, is also less prominent than in my new species.

The second Burmese species is represented by a very large and fine left upper molar,* which must have belonged to a very large animal, and far exceeds the largest tooth of *Rh. Deccanensis* in size. It is less tall crowned; has the guard well developed anteriorly, but faintly only on the inner side. A fan-shaped denticule stands at the mouth of the pass into the relatively much shallower anterior valley, and a furrow in the enamel wall descends from the anterior collis into the valley just within the pass—a feature not met with in *Rh. Deccanensis*. There is only one simple crochet. The posterior area of the outer wall is deeply concave instead of being flat, and the posterior outer angle is much less acute than in the Deccan species.

Two right upper premolars, also in the Geological Museum, Calcutta, derived from an animal considerably smaller than *Rh. Deccanensis*, represent the third Burmese species. They are characterized by the excessive development of the second costa of the outer wall (k_2) in a very median position, and relatively much posterior to the position of the moderate-sized second costa in *Rh. Deccanensis*. Two straight spur-like crochets project into the very deep anterior valleys. The more forward of the two crochets, which corresponds to h_1 in my species (see Plate I, figs. 1 and 2), is the larger, and juts out nearly at right angles to the outer wall of the tooth. The anterior and median colles are narrower and more obliquely placed than those in *Rh. Deccanensis*. It is only on the anterior side of the front tooth that any guard is shown.

Associated remains.

At the same time that I obtained the remains of *Rh. Deccanensis*, I found, lying loose in the bed of the nullah, a fragment of a right maxilla with two teeth (probably *molars* 2 and 3) of a large bovine animal, allied to *Bibos gaurus*, which still lives in the Syhadri range.† The condition of the specimen and character of the encrustation covering it indicated that it came from a position corresponding to that of the Rhinoceros now described. In the following season, 1872, I had an opportunity

* This tooth was presented to the Geological Museum by General Sir Arthur Phayre, K. C. S. I., late Chief Commissioner of Burmah.

† The proper name of the so-called Western Ghâts.

of revisiting the locality for a few hours, and besides collecting a variety of fragments, some belonging apparently to the individual I have described, and others to a smaller but very similar Rhinoceros, I also had the good fortune to find a great part of the skull and many vertebræ of a large bovine whose teeth are identical with those obtained in 1871. As in the case of the Rhinoceros, these bones broke up a good deal during and after extraction, and I have not yet had an opportunity of restoring them and determining the species of the animal.

The bovine remains were found in the bed of very dark brown clay underlying the black clay in which the Rhinoceros occurred, and intermediate between these two formations I found two thin beds of clayey grit containing numerous specimens of *Unio* [redacted]. These shells have all been identified by my colleague, Mr. W. Theobald, as being of living species: the age of the formation they occur in, and of the overlying bed containing the Rhinoceros, may, therefore, be reasonably regarded as pleistocene. There is no record of the existence of Rhinocerotes so far south in the Peninsula of India, nor, as far as I could ascertain, does any tradition of their existence remain among the people. When the individual in question inhabited that region, the principal geological features were probably but little different from what they are now, but the general surface was doubtless covered with vast forests and morasses. Many features of the present surface indicate that various lakes or jheels existed at intervals along the valley of the Gatparba River, formed by the damming back of the waters by several rocky barriers, which have since been worn or broken through and the lakes consequently drained.

The spot at which *Rh. Deccanensis* and the other bones were found lies well within the area of the uppermost of these supposed lakes, which was drained by the lowering of the rocky barrier, in this case of trap, which crossed the Gatpurba Valley at Tegree (Tegedi) some ten miles north-east of Gokak. The idea that this valley was occupied by a lake in former times had been arrived at quite independently by my friend Mr. A. C. Palles, C. E., from the data he obtained when carrying out a great series of levellings in connection with Government irrigation schemes in the Gatpurba Valley.

The Rhinoceros lived no doubt among the swampy valleys at foot of the Gokak hills, and its remains were drifted into the lake after its death.