PALÆONTOLOGICAL MEMOIRS AND NOTES

OF THE LATE

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AT SUHARUNPOOR AND CALCUTTA.

WITH A

Biographical Sketch of the Author.

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FAUNA ANTIQUA SIVALENSIS.

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CONTENTS

OF

THE FIRST VOLUME.

VI. ON THE SPECIES OF FOSSIL RHINOCEROS FOUND IN THE SEWALIK HILLS.

[Three species of fossil Rhinoceros from the Sewalik hills are figured in the Fauna Antiqua Sivalensis (Plates LXXII. to LXXIX.), viz.: *R. Sivalensis*, *R. Palæindicus*, and *R. platyrhinus*, the two former characterized by the curved line of the upper plane of the head, the last by the upper plane of the head being straight and broad. (See Pl. XIV.) No complete description of the species was ever published or written by Dr. Falconer. The following account, which appears to refer mainly to *R. Sivalensis* (although the possibility of there being two species is hinted at), is extracted from a memoir on Sub-Himalayan Fossils, by Messrs. Baker and Durand, published in the Journal of the Asiatic Society for August, 1836, vol. v. p. 490. The annexed illustrations are copied from the Fauna Antiqua Sivalensis, and the reader is referred to the descriptions of the Plates in the Fauna for further particulars. Professor Owen, in his 'Odontography'[1] makes the following statement. 'In one of the extinct species of Rhinoceros from the 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.' The species referred to was evidently *R. Sivalensis*, for Plates LXXII. fig. 4 *b*, LXXIV. fig. 4, and LXXV. fig. 10, F.A.S., of the Fauna Antiqua Sivalensis, show that the remark does not apply to *R. platyrhinus* or *R. Palæindicus*. (See Pl. XIV. fig. 4.) The following note, also, on Colonel Baker's large specimen of the skull of the *Rhinoceros platyrhinus* in the British Museum, was written by Dr. Falconer in his Notebook for 1860: '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 *R. hemitœchus*, in having a posterior basal funnel-shaped pit; while the penultimate and antepenultimate true molars, and the penultimate and antepenultimate milk molars, have each three distinct fossettes, as in *Rhinoceros tichorinus*! The vertical ridges of the outer side are very well pronounced in three valleys. The animal had two large incisors above and four below: of the latter, the two outer are big, the two inner small, as in the existing Indian Rhinoceros.' In the 'Fauna Antiqua Sivalensis,' there are likewise illustrations of fossil Rhinoceros from Perim Island (*R. Perimensis*), and from the valley of the Nerbudda.—Ed.]

[1] Vol. i. p. 589.

I.—Description by Messrs. Baker and Durand of the Fossil Rhinoceros of the Sewalik Hills.

(*Reprinted from the Journal of the Asiatic Society for August*, 1836.[1])

Cranium.—We shall commence with the fossil which, being the most perfect, affords the best means of instituting a comparison with the skulls of described species.

The fossil cranium is imperfect in the following parts. The extremity of the nasal and intermaxillary bones is broken off; the zygomatic arches are both fractured; the left occipital condyle is wanting; the following molars have either dropped out prior to the envelopment of the head by the matrix, or have been broken off subsequently to its fossilization, viz. the fifth of the right, the first and seventh of the left, maxilla. In addition to these losses, the cranium has undergone, when in the stratum, the common fate of Sub-Himalayan relics, and is cracked in several directions; the crush, however, which produced these cracks has not materially altered the form of the head; the chief effect produced has been the forcing the left half of palate at its anterior extremity a little above its proper level; this the longitudinal crack passing through the left orbit enabled it to accomplish; the displacement resulting may be best observed in the profile view of the skull, fig. 3. The transverse cracks are accompanied by a small hollow and a consequent neighbouring bulge, both so partial and of such small relief, that in the profile their places can only be observed by paying attention to the jagged outline at the depression of the frontals. With the above exceptions the specimen is perfect.

A glance at Pl. XV. will be sufficient at once to determine the species with which this fossil rhinoceros must be compared. The depression of the frontals causing the deeply curved outline of the upper planes of the head, the slope of the occiput, the septum, and the nasal arch all separate this cranium from the existing and fossil bicorn species. The existing unicorn species is that, therefore, to which recourse must be had in order to establish a comparison.

In the unicorn rhinoceros of Java the height to which the crest of the occiput rises above the palatal plane, and also the thickness and prominence of the nasal arch supporting the horn, are less than in the Indian rhinoceros. A line drawn at a tangent to the crest of the occiput and the highest point of the nasal bones will, in the unicorn species of India, be more raised above the plane of the frontals than is the case in the Javanese rhinoceros. In the foregoing respects the fossil associates itself with the Indian, and differs from the Java, species. The comparison may, therefore, in general be confined to the former.

With the view of bringing at once under the eye, the discordance which occurs between the relative values of analogous dimensions, the subjoined table is here inserted. The modulus chosen is the space occupied by the seven molars, because on this measurement the development of the bones of the head must, to a certain extent, be dependent. The measurements given in Cuvier's 'Oss. Foss.' have afforded the proportions of the existing species; and the table of dimensions which closes this paper has given the proportions of the fossil.

[1] The illustrations referred to are those in the 'Journ. Asiatic Society.'—[Ed.]

DESCRIPTION OF PLATE XIV.

Rhinoceros Sivalensis and Rhinoceros platyrhinus.

Fig. 1. Profile view of skull of *Rhinoceros Sivalensis*, with three true molars and three posterior premolars, one-eighth of the natural size. Copied from a drawing by Mr. Dinkel, in the Fauna Antiqua Sivalensis, Plate LXXIII., fig. 2 *a*. The specimen is in the British Museum. (See pages 157 & 514.)

Fig. 2. Fragment of upper jaw, right side, of *Rhinoceros Sivalensis*, with three true molars and two last premolars, one-fourth of the natural size. Copied from a drawing by Mr. Ford in the F. A. S., Plate LXXV., fig. 5. The specimen is in the British Museum. (See pages 157 & 516.)

Fig. 3. Profile view of cranium of *Rhinoceros platyrhinus*, one-eighth of the natural size. Copied from a drawing by Mr. Dinkel, in the F. A. S. Plate LXXII., fig. 1. The specimen is in the British Museum. (See pages 157 & 513.)

Fig. 4. Lower jaw, with incisive border of *Rhinoceros platyrhinus*, showing two outer large and two central small incisors, one-fourth of the natural size. Copied from a drawing by Mr. Ford, in the F. A. S. Plate LXXV., fig. 10. The specimen is in the British Museum. (See pages 157 & 517.)

Fig. 2.

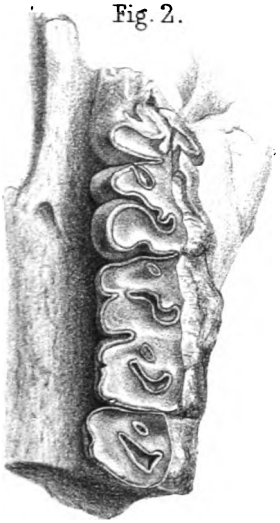

Fig. 4.

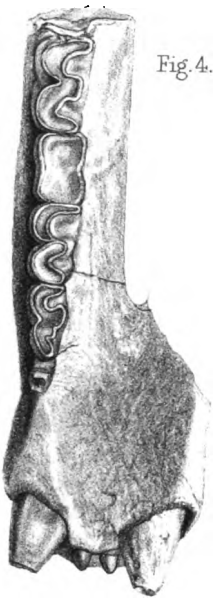

Fig. 1.

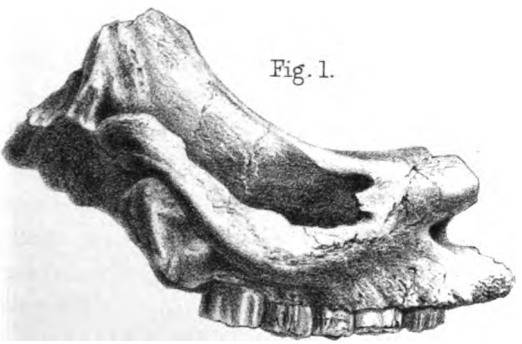

Fig. 3.

G.H.Ford del. J.Dinkel lith. W.West imp

1, 2. Rhinoceros Sivalensis. 3, 4. R. platyrhinus.

Measurement	Cuvier's Ind. Rhin.	Fossil Ind. Rhin.
Space occupied by the seven molars assumed equal to. .	1·00	1·00
Height of occiput from lowest edge of occipital foramen to summit of crest of occiput	1·02	0·80
Greatest breadth of occiput	1·11	1·05
Least thickness of cranium across temporals . . .	0·45	0·38
Breadth across at post-orbital apophysis of frontals . .	0·83	0·78
Distance from anterior of orbit to auditory foramen . .	1·02	1·00
Breadth across the occipital condyles	0·47	0·60

Referring to the table of dimensions it will be observed, that the height of the occiput is in the fossil less by mèt. 0·021 than the corresponding measure of Cuvier's Indian rhinoceros; but the greatest breadth of the occiput is mèt. 0·036 in favour of the fossil; relatively to the space occupied by the seven molars, these two measurements attain a less development in the fossil than in the existing animal. The difference in the occipital condyles amounting to mèt. 0·065 in excess of the Indian rhinoceros causes a marked discordance in the ratios of these dimensions; but, as the left condyle and the adjacent parts are wanting in the fossil, the measure was obtained by doubling what appeared to be the exact half dimension; this of course is not so satisfactory as if the condyles had been perfect; any inaccuracy consequent on this circumstance could not, however, amount to a quantity which would materially alter the deduced proportion. The occiput, figs. 8, 9, Pl. XVII., is fortunately very perfect; from its dimensions, which prove it to have belonged to a smaller animal than the cranium of Pl. XV., it may also be concluded, that though inferior in size to Cuvier's specimen of the Indian rhinoceros, which in greatest breadth of occiput exceeds it by mèt. 0·039, yet the space occupied by the condyles is 0·010 in favour of the small fossil occiput. In both of the fossils the depressions near the summits of the occiputs on each side of the mesial projections are deeper than those of the existing species.

The zygomatic arches not being entire, and the matrix being uncleared from the portions which remain, no particular remarks can be passed on them.

The sutures cannot anywhere be traced; a circumstance which precludes the notice of particulars frequently of importance in the comparison of species.

The least thickness of the cranium is but mèt. 0·001 greater than that of the Indian rhinoceros; and therefore in proportion to the modulus, yields a less ratio than that species.

The breadth at the orbits is mèt. 0·024 greater than in the existing species; consequently the skull does not in this part present any material discordance of proportion.

The length between the auditory foramen and the anterior of the orbit is 0·043 mèt. greater in the fossil; this measurement affords a proportion only differing mèt. 0·002 from that obtained from the existing species.

The infra-orbital foramen is situated similarly to that of the Indian rhinoceros.

The nasal arch is massive and much developed; the spring of this arch is perpendicularly over the anterior of the second molar; that is a little more retired than in the Java or Indian rhinoceros skulls, given in Cuvier's Pl. IV.

The breadth of the palate has not been given in the table of dimensions, because the first and seventh molars not being perfect on both sides, measurements corresponding to those of Cuvier's could not be obtained. It is comparatively less than in the existing species, but the great breadth of the teeth compensates for this difference.

Having detailed the essential differences and the points of resemblance observable in the fossil Indian rhinoceros when compared with Cuvier's dimensions of the existing Indian rhinoceros, we must be permitted to add, that additional measurements from skulls of the latter species are requisite before anything certain can be pronounced as to the amount of difference or correspondence between the two species. We are induced to make this remark in consequence of having been favoured with the examination of two craniums which presented considerable variation of proportions when compared with Cuvier's and with each other.

It appears to us desirable, therefore, to ascertain the limits within which individual variations range before anything positive can be asserted. The foregoing remarks will have shown a great general resemblance, accompanied by a departure of proportions in some corresponding parts; the latter may be sufficient for the establishment of a new species—at least for the present, until more data are obtainable whence to determine the bounds by which the individuals of one species are limited in their variations. For the sake of distinction, therefore, and present convenience, at the same time keeping in view the type to which it is a near approach, we have termed the species under consideration the *R. Indicus fossilis*.

Teeth.—The remark has been already passed, that the greater number of fossils obtained from the Moginund deposit are the remains of young animals; with the rhinoceros this has been particularly the case. We accordingly find ourselves better able to illustrate the early stage of dentition than that more advanced.

Fig. 1 contains the four milk molars of the left maxilla; the fourth being but just cut is unworn; but the palate being broken away from the base of the tooth, more of it is seen than would otherwise be the case; in the right half of the specimen, where the palate is whole, the fourth molar is more concealed. The first molar is also unworn, but the second and third have suffered detrition. The two rows of teeth have their internal base lines parallel to each other, and the lines which would circumscribe their exterior much curved, in consequence of the difference of breadth which exists amongst the teeth. The upper part of an unworn tooth, measured exteriorly, is much longer than the lower; for the anterior of each molar projects beyond the posterior extremity of the one immediately in its front by the gradual enlargement of the external line of enamel from the base to the summit. As the molars wear down, this outer development is reduced, the internal sides of the teeth come more into use, and breadth is gained in compensation for the diminished length of surface in wear.

Fig. 5, Pl. XIX. The sixth molar from a left maxilla. The spur, which occupies no inconsiderable part of the hollow between the

anterior and posterior transverse hillocks, is here less curved than that of the Indian rhinoceros; and there is wanting altogether the small salient of enamel, which in the Indian rhinoceros occurs between the starting point of the above-mentioned spur and the point of junction of the exterior and anterior main lines of enamel. It may also be mentioned, that the exterior and posterior lines of enamel being less thick than the corresponding parts of the sixth molar of the Indian rhinoceros, there is a greater space between the two. Such modifications of form are however fortuitous, differences of equal amount being observable in the teeth of animals of the same existing species.

This fossil measures in length . .	in. 2·50	mèt. 0·0645
„ in breadth . .	„ 2·62	„ 0·0675

Fig. 6. The 5th molar, derived from a left maxilla. The outline of its enamel accords with that of the similar tooth of the Indian rhinoceros, the only difference being in the dimensions and in the emamellated edge of the short beading at the anterior side of the tooth.

It measures in length	in. 2·08	mèt. 0·053
„ in breadth . . .	„ 3·27	„ 0·0835

Fig. 7 is the 7th molar, and from a right maxilla; the point of the small spur is broken, as also the anterior extremity of the external line of enamel; but the tooth is sufficiently perfect to show a close resemblance to the analogous molar of the Indian rhinoceros.

It measures in length	in. 2·88	mèt. 0·0735
„ in breadth . . .	„ 2·53	„ 0·065

Fig. 8 is the 7th molar of a left maxilla. The difference observable between this and the foregoing specimen consists in the great development which the small anterior spur here attains. In the former, it is scarcely observable; in fig. 8 it is very prominent. Variations to an equal amount may, however, be observed in the minor salients, &c., of enamel in teeth appertaining to skulls of the same existing species. No weight can therefore be attached to such unimportant modifications.

This fossil measures in length . .	in. 2·95	mèt. 0·075
„ in breadth . .	„ 2·55	„ 0·065

The cranium Pl. XV. has its molar teeth so much worn down that the configurations of the enamel cannot be traced. The table of dimensions gives the length and breadth of each tooth, and shows that although the lengths do not materially differ from those of the corresponding teeth of the existing species, the breadths exceed those of any hitherto described.

Without complete illustrations of the milk-teeth of existing species, it would be dangerous to attempt a comparison between them and the fossil Indian rhinoceros. We have therefore avoided the endeavour; but we must be allowed to notice the upper jaw fig. 4, Pl. XIX., which offers peculiarities when compared with figs. 1, 2, and 3 (of the same plate), deserving of remark.

The right half of the specimen is figured in the plate, the left half having lost the first tooth. With respect to age, this jaw nearly corresponds with fig. 3, the fifth molar being in both on the point of appearance. The following departures from the tracing of enamel in figs. 1, 2, and 3, may, however, be observed. The second molar of

fig. 4 has this peculiarity, that instead of the anterior portion of the tooth being one continuous offset from the exterior line of enamel, it only assumes that appearance after considerable detrition, consisting at first of a short offset and an isolated pillar, as shown in the drawing. The two sides of the jaw have been very unequally worn, in consequence of which the opposite side to that delineated has the pillar and offset conjoined. The third molar also presents a marked difference when placed in juxtaposition with the corresponding teeth of the other three jaws: the two spurs which occupy the central hollow of the tooth are of a different shape from that which occurs in the other specimens. In other respects, fig. 4 corresponds with them: its rows of molars are parallel to each other, and the dimensions offer but trifling variations. The modifications of form above alluded to, unless fortuitous, which is perhaps improbable, denote the existence of another species—a fact corroborated by the examination of the milk molars of the lower jaws in our possession. Upon the consideration of these we now enter, but are able to offer but few and unsatisfactory remarks.

Lower Jaws.—With the exception of the fine fragment, fig. 6, Pl. XVI., submitted to our inspection by Conductor Dawe, and the fragment, fig. 9, the specimens of lower jaws are all from the Maginnud deposit, and all the remains of young animals.

Fig. 1, Pl. XVI., represents a fossil which has lost the interior of its symphysis, the second molar on the right, and the first molar on the left side of the jaw, as also both the rami, which are broken off. Four molars have appeared, the second and third of which are worn; but the first and fourth have their enamel intact. The sections of fracture expose germ teeth. The two lines of molars have a gentle convergence, which is effected, not by a curve in the rows of teeth, for these are set in a perfectly straight line, but by the gradual approach of the two rows, which make a small angle with the median line of the jaw. The section shown by the break of the symphysis and the interval between the front molars argues the existence of a prolonged symphysis. The fourth molar is characteristic, having an isolated point or low pillar in the centre of the chord of its posterior crescent.

Fig. 4 is the right half of the lower jaw of a young rhinoceros, but of one somewhat older than the animal to which fig. 1 belonged, for the fourth molar has in fig. 4 suffered detrition. Notwithstanding the difference of age being in the favour of this specimen, the space occupied by the four molars is less than that of the four in fig. 1. The fourth molar is here devoid of the low isolated pillar in the posterior crescent, and has the central enamel, or junction of the two crescents, larger than in fig. 1. There are no means of ascertaining whether or not the opposite rows of molars were parallel, but in the position of symphysis and set of the teeth in a perfectly straight line, this specimen corresponds with the foregoing.

Fig. 2 has its fourth molar just disclosed, and rising into the line of molars. It is devoid of the isolated pillar; but in size corresponds with fig. 1, instead of fig. 3, to which latter it assimilates itself by the fourth and second molars.

It is difficult to ascertain the degree of importance to be attached to such points of difference. In no specimen from the jaw of an adult

animal has any trace of the isolated pillar been hitherto found. Occurring as this peculiarity does in a deciduous tooth, should nothing similar take place in the permanent tooth which replaces it, the only chance of determining the question will be the discovery of an entire head. We have noticed an upper jaw, fig. 4, Pl. XIX., which indicates the probability of the existence of two species. The examination of the above lower jaws rather confirms this supposition; but in the event of such slight modifications denoting specific distinctions, we are unable, in consequence of the paucity and incompleteness of specimens, to decide which are the milk-teeth of the fossil Indian rhinoceros. Nor are we fortunate with respect to the lower maxilla of the adult animal; figs. 6, 7, and figs. 8, 9, being all that we can bring forward. The sections of these two fragments differ, in consequence of their being derived, one from the posterior, the other from the anterior part of the jaw, which thickens as it approaches to the symphysis. These two specimens resemble the corresponding portions of the lower jaw of the Indian rhinoceros, but are too imperfect to afford any satisfactory measurements for grounds of comparison.

Anterior Extremity.

A scapula in our possession is not sufficiently perfect to give accurate measurements, but it bears as great a general resemblance to that of the Indian rhinoceros as do the other parts of the skeleton.

The humerus, figs. 1, 2, Pl. XVII., having its radius and ulna attached, was discovered by ourselves very close to the place whence we excavated the femur and tibia forming the subject of Pl. XVIII. With the exception of the deltoid crest, this humerus is perfect, and has afforded the dimensions which enter into the first column of the table. For the purpose of comparison, the five following columns are added. The proportions of the Indian and Sumatra small species of rhinoceros are deduced from Cuvier's table; those of the fossil specimens are of course from the Table of Dimensions. The length of the bone is assumed as the unit, and the measures of other parts referred to it, in order to obtain their comparative values.

Measurements	Cuvier's Ind. Rhin.	Cuvier's Sumatra Small Sp. Rhin.	Fig. 1, Pl. 17, fossil Ind. Rhin.	Fig. 5, Pl. 17, fossil Ind. Rhin.	Fig. 6, Pl. 17, fossil Ind. Rhin.
Length of humerus from tuberosity to external condyle	1·00	1·00	1·00	1·00	1·00
Ditto ditto ditto internal ditto	1·03	0·95	0·91	0·94	...
Greatest anter. post. diameter at top	0·44	0·30	...	0·44	0·43
Breadth across condyles .	0·36	0·31	0·35	0·37	...
Ditto of articulating pulley .	0·25	0·19	0·22	0·22	0·25
Least diam. of the body of the humerus	0·15	0·13	0·14	...	0·15
Length of radius . . .	0·79	0·75	0·76	...	...
Breadth at top . . .	0·26	0·20	0·23	...	...
Ditto at bottom . . .	0·25	0·18	0·23	...	...
Length from articulating head to bottom of internal condyle	...	...	0·82	0·81	0·87

The Sumatra rhinoceros (small species) concurs with the fossil Indian rhinoceros in having the length taken to the external condyle longer than that taken to the internal. The Javanese and the larger Sumatra species also accord with the fossil in this respect, but not so nearly as the small Sumatra species, which has consequently been introduced into the above table.

The length of the fossil humerus, figs. 1, 2, Pl. XVII., exceeds that of any of the existing species: its thickness is, in proportion to the length of the bone, intermediate between the Sumatra and Indian species. The articulating pulley also possesses a development intermediate in value to those of the two existing species. The breadth at the condyles is in the same proportion, or nearly so, as that of the Indian rhinoceros. The radius is in length, considered with reference to length of femur, a little less than in the Indian, and somewhat in excess of the small Sumatra species. The remaining two dimensions of this bone yield values intermediate to those of the two existing rhinoceroses. These remarks apply to the deductions for fig. 1; nor would it be necessary much to alter them in speaking of fig. 5; but fig. 6 presents such a close approximation to the Indian rhinoceros, that it is much to be wished that the specimen had not been so broken as to prevent additional measurements being derived from it. Excepting in the length from the articulating head to the bottom of the internal condyle, it does not much differ from fig. 5. The bone, however, being imperfect, must be omitted in drawing a comparison between the fossil and existing species.

Fig. 1 varies most from the Indian rhinoceros in the proportion of the length taken to the internal condyle—an anomaly difficult of explanation. We must here repeat, that there exists a necessity for a greater number of tables of dimensions taken from the skeletons of the Indian rhinoceros. The anterior extremity of a rhinoceros, with the examination of which we have been favoured, yielded proportions so nearly corresponding with those deduced from the fossil humerus, figs. 1, 2, as to prevent our drawing more positive conclusions than those expressed at the close of the remarks on the cranium, Pl. XV.

Posterior Extremity.

The femur and tibia, Pl. XVIII., were dug up in such close proximity to the humerus and radius, fig. 1, Pl. XVII., that little doubt could be entertained of their having belonged to the same animal. Being perfect, except at the lower part of the great trochanter, the specimen affords ample means of comparison with the femur of the existing species.

On reverting to the Table of Dimensions, it will be observed that this fossil exceeds, as did also the humerus, any of those in Cuvier's table of existing species. The following columns show in what respects the proportions of the bone vary from those deduced from Cuvier's Indian rhinoceros. The length of the femur is here the modulus.

From a comparison of the two first columns in the annexed table there results that the fossil has a greater development at its upper, and a somewhat less development at its lower extremity, than is the case in the Indian rhinoceros. The third trochanter is set lower down, and the inferior extremity of the small trochanter higher up than in the existing

species; the articulating head is larger in proportion in the fossil than in the Indian rhinoceros. None of these modifications, however, are excessive; on the contrary, they are less than those which exist amongst the fossils themselves, which are all three undoubtedly of the same species.

Measurements	Cuvier's Ind. Rhin.	Fossil Pl. 18	Fossil 3rd in table of dimensions	Fossil 5th in table of dimensions
Length of femur from articulating head to bottom of internal condyle .	1·00	1·00	1·00	1·00
Breadth from head to most salient part of great trochanter	0·38	0·43	.r.	...
Breadth across condyles . . .	0·29	0·28	0·26	...
Antero-post. diam. of internal condyle .	0·34	0·34	...	...
Ditto ditto of external ditto . . .	0·27	0·26	...	...
Distance between bottom of 3rd trochanter and top of 1st . . .	0·59	0·61	...	...
Ditto ditto ditto small trochanter and top of head of femur	0·46	0·41	0·46	0·42
Diam. of articulating head of femur .	0·18	0·19	0·16	0·17
From lower side 3rd trochanter to bottom of external condyle . . .	...	0·38	0·38	...
Length of femur from articulating head to bottom of 3rd trochanter . .	...	0·72	0·71	0·64
Length of tibia from anter. tubero. to anter. edge of inferior articulating surface	0·67	0·70	...	...
Greatest transverse diam. at top . .	0·25	0·25	...	...
Antero-post. diam. from antero-post. tubero. to post. ext. of internal condyle.	0·29	0·31	...	...
Transverse diam. at bottom . . .	0·21	0·20	...	...
Diam. antero-post. of internal side .	0·14	0·13	...	...
Length of fibula	0·62	0·65	...	...
Breadth at bottom	0·10	0·10	...	...

From the manner in which the lower and exterior part of the great trochanter is broken there is every probability that a descending point protruded from the fractured surface towards the third trochanter, the ascending point of which is very perfect.

The third trochanter, however, differs from that of the existing species as figured in Cuvier's 'Oss. Foss.,' in not possessing the double point; for it has a single well-defined ascending process, without any sign of the bicuspid termination. The lower edge of this trochanter, instead of ascending with a gradual swell towards the point, as in the existing species, has a counter curvature to that of the upper edge. The chief dissimilarity between Cuvier's plate and the fossil occurs in this part of the bone, the third trochanter assuming a different shape, and offering a variation more distinctive than any other presented in either extremity. This circumstance, together with some of the proportions of the cranium, has led us for the present to distinguish these remains by appending the word fossil to the name of that species of which they are the prototype. But we dwell on the necessity of more

extended research, and the collection of a greater series of tables of dimensions of the Indian rhinoceros, before anything absolutely conclusive can be pronounced with regard to the fossil and existing species.

We have had no hesitation in ascribing the two limbs dug up in such close neighbourhood to the same animal. An additional confirmation of the correctness of the assumption may be derived from the proportion which exists between these two extremities, when compared with that which occurs in the Indian rhinoceros.

Ind. Rhin. femur and tibia	mèt. 0·960	humerus and radius	mèt. 0·868
Fossil Ind. Rhin. do. do.	„ 1·056	ditto ditto	„ 0·947

In the first, the humerus and radius are to the femur and tibia in the ratio of 1 : 1·10; in the fossil, the ratio is 1 : 1·11.

The analogy which exists between these fossil extremities and those of the Indian rhinoceros being no less striking than that which was observed between the cranium, Pl. XV., and the skull of the existing species, we have considered such correspondence sufficient to prove that the fossil anterior and posterior limbs appertained to an animal of the same species, and of about similar size to the one of which the cranium in question is a relic.

Even in the event of a much closer approximation of symmetrical proportions than that given in this paper being obtained, we are aware that identity of species could not be presumed. It could not be assumed that the skin and the external appearance of the animal were precisely similar to those of the existing species. The fossil Indian rhinoceros must, however, have presented a figure bearing a strong general resemblance to the uncouth symmetry of its present representative.

Measurements of Anterior Extremity.	Sp. 1		Sp. 2		Sp. 3		Sp. 4		Sp. 5	
	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.
Length of humerus from tub. to external condyle	·538	21·20	·488	19·22	·482	19·0	...	...	...	...
Do. do. do. internal do	·492	19·38	·461	18·15	...	...	...	...	...	...
Greatest anter. post. diam. at top	...	...	·218	8·60	·208	8·20	·200	7·90	...	...
Breadth across condyles	·193	7·60	·183	7·22	...	...	...	...	·176	6·94
Breadth of the articulating pulley	·119	4·70	·111	4·40	·121	4·80	·104	4·10	·109	4·30
Least diam. of the body of the humerus	·078	3·07	...	...	·073	2·90	·071	2·82	·069	2·75
Length of the radius	·409	16·10	...	...	..	...	...	...	...	...
Breadth at top	·124	4·90	...	...	...	...	...	...	...	...
Ditto at bottom	·124	4·90	...	...	...	...	...	...	...	...
Length of humerus from art. head to internal condyle	·441	17·40	·393	15·51	·420	16·55	·389	15·35	·398	15·70

Measurements of Posterior Extremity	Sp. 1		Sp. 2		Sp. 3		Sp. 4		Sp. 5		Sp. 6	
	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.
Length of femur from ant. head to bottom of 3rd trochanter	·449	17·70	...	...	·383	15·10	...	...	·328	12·94	·369	14·56
Length of femur from ant. head to bottom of internal condyle	·621	24·45	...	...	·539	21·25	...	...	·510	20·10	...	...
Breadth from head to most salient part of great trochanter	·269	10·60	...	...	...	...	...	...	...	...	...	...
Breadth across condyles	·173	6·82	...	...	·143	5·63	·146	5·75	...	...	...	...
Antero-post. diam. of internal condyle	·214	8·45	·221	8·70	...	...	·166	6·55	...	...	...	...
Ditto do. do. external condyle	·161	6·35	·162	6·40	...	...	·139	5·48	...	...	...	...
Distance between bottom of 3rd trochanter and top of 1st	·383	15·10	...	...	...	...	...	...	...	...	...	...
Distance between bottom of small trochanter and top of head of femur	·259	10·20	...	...	·249	9·80	...	...	·215	8·50	·231	9·10
Diam. of articular head of femur	·118	4·65	...	...	·086	3·40	...	...	·089	3·50	·083	3·30
From lower side 3rd trochanter to bottom of external condyle	·242	9·53	·177	7·00	·208	8·20	·266	10·50	...	...	...	...
Length of tibia from anter. tubero. to anter. edge of infer. artic. surface	·435	17·15	...	...	...	...	...	...	...	...	...	...
Greatest transverse diam. at top	·156	6·15	...	...	...	...	...	...	...	...	...	...
Antero-post. diam. from anter. tub. to post. ext. of internal condyle	·195	7·70	...	...	...	...	...	...	...	...	...	...
Transverse diam. at bottom	·128	5·05	...	...	...	...	...	...	...	...	...	...
Diam. of antero-post. internal side	·086	3·40	...	...	...	...	...	...	...	...	...	...
Length of fibula	·405	15·95	...	...	...	...	...	...	...	...	...	...
Breadth at bottom	·064	2·54	...	...	...	...	...	...	...	...	...	...

Measurements of the Head	Cranium		Occiput	
	Mèt.	In.	Mèt.	In.
Height of occiput from lowest edge of occipital foramen to top of crest	0·259	10·20	0·223	8·78
Greatest breadth of occiput, behind auditory foramen	0·341	13·44	0·266	10·50
Least thickness of cranium at temporal bones	0·126	4·95	...	...
Breadth between post. orbital apophysis of frontals	0·254	10·00	...	...
Distance from anterior of orbit to auditory foramen	0·325	12·80	...	...
Space occupied by the seven molars	0·324	12·75	...	...
Breadth across occipital condyles	0·195	7·70	0·140	5·51
Ditto of occipital foramen	...	...	0·0575	2·25
Height of ditto ditto	...	...	0·049	1·90
Distance between internal extremities of glenoid facets of temporal	...	...	0·0735	2·88
Ditto from lower edge of occipital foramen to median post. extremity of palate	0·368	14·50	...	...
Ditto from post. of right occipital condyle to spring of nasal arch	0·539	21·22	...	...
Ditto ditto ditto to anterior of orbit	0·449	17·71	...	...
Depth from edge of maxilla at 5th molar to upper surface of frontals	0·239	9·42	...	...
Greatest transverse width of nasals at horn site	0·174	6·86	...	...
Ditto external breadth at 6th molar	0·246	9·72	...	...
Thickness of cranium over the median post. extremity of palate	0·204	8·06	...	...
Height of highest point of nasal arch above anterior of palate	0·238	9·38	...	...
Perpendicular from a line tangential to the summit of crest and vertex of nasal arch to the depression of frontals	0·099	3·91	...	...

Measurements of Upper Molars	1st Sp.		2nd Sp.		3rd Sp.		4th Sp.		5th Sp.	
	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.
Greatest length										
Molar 1	...	...	·030	1·19	·0295	1·14	·030	1·20	...	...
2	·035	1·36	·034	1·335	·038	1·49	·0395	1·53	·039	1·49
3	·045	1·75	·0475	1·85	·053	2·07	·056	2·17	·045	1·74
4	·049	1·92	·058	2·26	·061	2·39	...	...	·056	2·20
5	·044	1·69	·061	2·37	...	...	...	...	...	...
6	·0495	1·95	...	...	...	...	...	...	...	...
7	·0755	2·96	...	...	...	...	...	...	...	...
Greatest breadth										
Molar 1	...	...	·024	0·95	·024	0·95	·0285	1·09	...	...
2	·059	2·31	·0385	1·5	·036	1·40	·041	1·58	·037	1·45
3	·080	3·15	·049	1·9	·045	1·88	·053	2·05	·051	2·007
4	·083	3·36	·0575	2·25	...	...	...	...	·059	2·30
5	·081	3·19	...	...	...	...	...	...	...	...
6	·089	3·48	...	...	...	...	...	...	...	...
7	·083	3·25	...	...	...	...	...	...	...	...

Measurements of Lower Molars		Sp. 1		Sp. 2		Sp. 3	
		Mèt.	In.	Mèt.	In.	Mèt.	In.
Greatest length of Molar . .	1	·016	0·61	...	...	·017	0·67
	2	·037	1·44	·0335	1·30	·033	1·29
	3	·053	2·09	·050	1·98	·0425	1·67
	4	·047	1·82	·056	2·18	·046	1·79
	5	...	...	...	...	...	...
	6	...	...	...	...	...	...
	7	...	...	...	...	...	...
Greatest breadth of Molar . .	1	...	...	...	...	·0115	0·46
	2	·020	0·77	·021	0·81	·018	0·70
	3	·026	1·01	·027	1·05	·025	0·98
	4	·029	1·12	·029	1·10	·030	1·19
	5	...	...	...	...	...	...
	6	...	...	...	...	...	...
	7	...	...	...	...	...	...

II.—Description by Dr. Falconer of Fossil Remains of Rhinoceros in Museum of Asiatic Society of Bengal. Reprinted from Catalogue of Museum.

A. From the Sewalik Hills.

No. 269. *Rhinoceros Sivalensis* ?—Fragments comprising the greater part of the cranium broken off behind about the posterior parts of the zygomatic arch, the fracture having removed the whole of the occiput and the left zygomatic arch. The specimen had also suffered from a crush acting from above downwards from right to left; the greater part of the parietal and the whole of the frontal, and also the united nasals are present; the right orbit broken off; the left nearly entire. The right maxillary shows the remains more or less of seven molars, the last broken off, the penultimate well worn; the anterior teeth have all their crowns broken off nearly on a level with the alveoli; on the left side, the crowns are all broken off; the palate seems narrow, but this may be probably owing to the crush; the tip of the nasal shows the rugous gibbosity of the base of a *very large* horn. The species was evidently unicorned. From the Sewalik hills near Nahun.

No. 270. *Rhinoceros* —— ?—Lower jaw, left side showing greater part of horizontal ramus, but broken off in front and behind, with the remains of four molars, the crowns all broken off.

No. 271. *Rhinoceros* —— ?—Lower jaw, right side, broken off in front at commencement of symphysis and behind at the coronoid, with remains of five molars, much mutilated. In condition like No. 270.

No. 272. *Rhinoceros* —— ?—Fine fragment comprising the lower end of tibia and fibula, right side, attached to each other and to the bones of the tarsus in their natural position, together with the greater part of the length of three metatarsals also united, and attached to the carpus: the inferior apophysis of the calcaneum is broken off, the tibia bent nearly at right angles with tarsus and metatarsus. All the bones are held together by argillaceous matrix in their natural relative position

in a manner which is remarkable for the fossil state among Sewalik remains. From the clay-marl of Maginnud. Figured by Messrs. Baker and Durand in Journ. As. Soc., vol. v. Pl. XVII. fig. 19.

No. 273. *Rhinoceros* —— ?—Upper extremity of humerus showing the head and upper trochanters; the descending spine of the large tuberosity broken off: of large size.

No. 274. *Rhinoceros* —— ?—Upper extremity of humerus, right side, showing the head and both tuberosities, as also the middle apophysis of the upper end.

No. 277. *Rhinoceros* —— ?—Right femur, articulating head with part of shaft attached; leafy expansion of third trochanter broken off.

No. 278. *Rhinoceros* —— ?—Shaft of femur, left side, articular epiphysis and trochanters broken off, base of leafy expansion remaining.

No. 280. *Rhinoceros* —— ?—Lower end of femur, left side, showing the condyles and trochlear pulley with a short portion of the shaft attached.

No. 283. *Rhinoceros* —— ?—Top of ulna, left side, showing articular pulley and part of olecranon.

No. 285. *Rhinoceros* —— ?—Upper half of right tibia with articular surface nearly entire.

No. 287. *Rhinoceros* —— ?—Astragalus, very perfect, of right side.

No. 288. *Rhinoceros* —— ?—Calcaneum, left side, nearly entire.

No. 289. *Rhinoceros* —— ?—Middle metacarpal of right fore leg entire.

No. 302. *Rhinoceros* —— ?—Entire humerus, left side found embedded in argillaceous matrix, which has been partly removed, laying bare the articular surfaces of both extremities together with the tuberosities, and a great part of the shaft on one side; the lower jaw of a horse, both rami, together with the lower end of the left femur of the same animal united to it on the other side by matrix. The humerus is of large size, and equal to Nos. 273, 274.

Dimensions.

	Inches
Length from tuberosity to external condyle	19·4
To internal ditto	18·8
Width of condyles	4·4

There is great obliquity in the plane of the distal end of the lower articulation, the outer condyle projecting very much beyond the inner, as in Baker and Durand's figure, Journ. As. Soc. vol. v. Pl. XVII. figs. 6 and 7.

A notable specimen as indicative of the manner in which the bones of different animals were washed together into the mud-beds of the Sewalik strata: the Maginnud bone-bed being a stratum of argillaceous earth: the bones soft and white and adhering to the tongue. The mud matrix penetrates into the cores of the hollow bones.

No. 324. *Rhinoceros* —— ?—Molar of upper jaw, nearly entire, with part of palate attached.

No. 326. *Rhinoceros* —— ?—Entire outer incisor, lower jaw right side.

No. 764. *Rhinoceros* —— ?—Lower end, right tibia, of large size.

No. 771. *Rhinoceros* —— ?—Top of right radius with articular surface.

No. 773. *Rhinoceros* —— ?—Astragalus (left) of a small-sized species nearly entire (*vide* No. 287).

No. 782. *Rhinoceros* —— ?—Scaphoid and Semi-lunar of the left carpus of the same individual fitting together and connected by matrix, both of large size.

No. 786. *Rhinoceros* —— ?—Cuneiform bone of left carpus.

No. 787. *Rhinoceros* —— ?—Cuboid of left tarsus agreeing in size nearly with *Rh. unicornis*, but differing in form.

No. 788. *Rhinoceros* —— ?—Fragment of left scapula, comprising glenoid cavity; tuberosity, and neck spine and lamina broken off; of the size of the Indian unicorned Rhinoceros.

B. From Perim Island.[1]

No. 29. *Rhinoceros Perimensis.*—Lower jaw, left side, including part of horizontal ramus, posterior angle and ascending ramus, and portion of the last molar: coronoid and condyle broken off: of very large size. Presented by Lieut. Fulljames.—See Journ. As. Soc., vi. 79.

No. 30. *Rhinoceros Perimensis.*—Fragment consisting of the superior maxilla left side, containing two molars, well worn.

No. 31. *Rhinoceros Perimensis.*—Lower jaw, right side, consisting of posterior angle with one unworn molar, and portion of ascending ramus, in three pieces: of much smaller size than No. 29, and probably of a young animal.

No. 33. *Rhinoceros Perimensis.*—Humerus, inferior end, right side, with articular surface.

No. 109. *Rhinoceros Perimensis?*—Fragment of left scapula comprising the glenoid cavity, neck and tuberosity together with the low commencement of the spine of very large size: the whole of the laminæ broken off. The curve of the glenoid cavity on the antero-posterior direction is very great: and the cup is much less circular than in the most of the known forms of rhinoceros. Doubtful if from Perim island: the matrix resembles that of specimens from Ava.

No. 110. *Rhinoceros Perimensis.*—Part of an upper molar vertically broken through transversely about the middle, agreeing in size with No. 30.

No. 111. *Rhinoceros Perimensis.*—Metacarpal, outer toe, left fore leg with both articular surfaces. The bone is short and the inferior articular surface very thick and oblique.

[1] See also Fauna Antiqua Sivalensis, Pl. lxxvi.

C. From Scinde.

No. 5. *Rhinoceros* —— ?—Inner metacarpal of left fore leg, a little mutilated at the upper articulation. It is proportionally very short and the upper articulation deep as compared with the Indian unicorned rhinoceros.

No. 6. *Rhinoceros* —— ?—Fragment of the left scapula of a very large species, showing the greater portion of the glenoid cavity, neck and a part of the spine: the greater part of the blade broken off. The lower margin of the glenoid cavity partly broken off. Tuberosity of very large size.

No. 8. *Rhinoceros* —— ?—Distal extremity of middle metatarsal, of large size, shaft broken off.

No. 10. *Rhinoceros* —— ?—Fragment of left scapula of a small-sized rhinoceros, showing glenoid cavity, neck and trochanter: blade broken off. Of a much smaller size than No. 6.

D. From Ava.

No. 23. *Rhinoceros* —— ?—Fine fragment comprising the lower half of the right humerus with the articular surface very perfect: an old animal, very nearly of the size of the Sumatran Rhinoceros.

No. 24. *Rhinoceros* —— ?—Lower end of radius right side, showing the articular surface with part of the shaft of very large size. Width of articular head being 5·7 inches: Antero-post. diam. 3 inches.

No. 25. *Rhinoceros* —— ?—Fragment of Os innominatum of large size.

No. 26. *Rhinoceros* —— ?—Axis, a good deal mutilated, showing the greater part of the body, but the apophyses broken off; posterior articular surface cup-shaped; odontoid process thick and massive: belonged to an animal of large size. In mineral condition and wearing this resembles some of the Perim Island fossils.

No. 245. *Rhinoceros* —— ?—Detached molar, very much worn and mutilated.

VII. ON THE FOSSIL RHINOCEROS OF CENTRAL TIBET AND ITS RELATION TO THE RECENT UPHEAVAL OF THE HIMALAYAHS.[1]

BY H. FALCONER, M.D.

THAT fossil bones occur on the Hīoondès or elevated plain of Tibet, at the northern face of the Himalayahs behind the sources of the Ganges has long been well known. They are brought to Almorah by the Bhoteah merchants, and sold as talismans or charms under the name of 'Bijli ki hār' lightning bones; ammonites, from the crests of the neighbouring snowy passes, called 'Chakar futteer' and venerated all over Hindostan as the sacred Salagram, are generally found mixed up with them. The occurrence of these organic mammiferous remains appears to have been first established by Captain Webb and Mr. Traill; but little or no attention has yet been paid to the determination of the species, the circumstances under which they are found, or the general results to which they lead.

Some of these fossils belong to a large species of Rhinoceros, others to a bovine ruminant, as large as the Indian wild buffalo; and when it is remembered that the bed of the Sutlej, where it flows through the Hīoondès or Steppe of Chāng-tang at a lower level than the situation of the stratum in which the bones are found, is elevated 15,000 feet above the sea, and that the natural vegetation at present hardly anywhere attains the size of a shrub—not to mention the Polar severity of the climate—it will at once be seen that the case involves important considerations regarding the physical changes which must have taken place in this part of the Himalayahs since the Rhinoceros remains were entombed in the stratum where they are now met with. But to give any value to the results, it is necessary that all the facts of the case be subjected to a rigid investigation.

[1] This interesting paper, which was probably written about the year 1839, is now for the first time published. Fragments of bones of fossil Rhinoceros and Equus, from the Niti Pass, are to be found in the British Museum, and are figured in the Fauna Antiqua Sivalensis, Plates lxxvi. and lxxxiv.—[ED.]

And, first, in regard to the fact of fossil bones occurring in the Hīoondès. No competent European observer has as yet seen them *in situ*. Moorcroft and Hearsay are the only travellers who have *traversed* the tract where they are said to occur. They went over the Niti Pass, and thence north across the plain of Chāng-tang by Dhapa to Gortope; thence eastward to the lake Manasarovara and back to Niti by another route along the Sutlej, the course of which they followed to Dhapa. Their journey embraced about a degree of longitude and latitude through the tract where the fossil bones are said to be found. But Moorcroft nowhere makes any mention of them; 'Bijli ki hăr' are not even noticed in his narrative. He describes lofty gravel and clay precipices near Dhapa, and states his disappointment at not finding traces of marine remains in them. He also mentions having found abundance of ammonites at the Changlu river, under the Niti Ghati, on his return route. Captain Webb ascended to the crest of the Niti Pass and procured fossil bones brought from the plain of the Hīoondès, some of which, to be noticed in the sequence, are figured in Royle's Illustrations of the Botany of the Himalayahs, Pl. III. Mr. Traill,[1] in his Bhoteah and Kumaon reports, mentions the occurrence of fossil bones, and says they 'would appear to have belonged to some large animal of the ox species, probably the Yak.' He further states 'that the *Bijli ki hăr* are chiefly found at the crest of the Niti Pass.' Mr. Batten, in his most graphic account of a visit to the Niti Pass,[2] says he advanced about two miles beyond the ravine of the Sianki river on the Steppe of the Hīoondès and came upon the Ammonite Fossil Ground. He subsequently mentions having 'a good many fossil bones from the interior of Tibet and the Mana Pass;' but it does not appear that he saw any of them *in situ*. The fact, therefore, of their occurrence still wants the important testimony of direct observation; but the other evidence to the point is so good as to leave no room for reasonable doubt on the subject. This evidence is as follows:

1. The concurrent statements of good observers, such as Webb, Traill, and Batten, supported by specimens, that fossil bones are found in the northern faces of the Niti and Mana Passes, and the Steppe of the Hīoondès.[3]

2. The direct testimony of the Bhoteah merchants who

[1] Asiatic Researches, vol. vii. p. 17.

[2] Jour. Asiatic Soc. vol. vii. p. 310.

[3] Mr. McClelland does not appear to have had an opportunity of examining these fossils, but he states that 'a skull, said to be that of an elephant, was brought down from a very high elevation to the Commissioner of Revenue in Kumaon, during my residence in the province; but not having inspected the fossil, I cannot answer for the fact.'—*Kumaon Inquiries*, p. 216.

bring the fossil bones to Almorah; they state that they are found in ravines in the plain below the Snowy Passes.

3. The universality of the belief at Almorah, where the *Bijli ki hār* are brought, that they come from the plains of Tibet, and from nowhere else.

4. The absence of any grounds tending to discredit the evidence in favour of the fact.

Next in regard to the geological features of the fossil tract. Mr. Batten,[1] from whom the most of what follows is derived, describes the rocks from the southern side up to the crest of the Niti Pass: talc and clay slates predominate near Malari; quartz rock, mica, schist, gneiss, and granite between Malari and Gumsali. The granite contains abundance of tourmaline and kyanite, as is the case all along the culminating axis of the mountains between the valley of the Spiti and the Eastern sources of the Ganges. Above Gumsali the road leads along granite and gneiss precipices. At Niti the formations appear to alter, clay slate rising into hills with a rounded outline, and a compact uncrystalline blue limestone succeeding the granite series, and higher up an arenaceous quartzose rock. From the source of Dhauli river to the crest of the pass the road leads up through crumbling of crags of blue limestone, the top of the pass being strewed with blocks of this rock and arenaceous quartz. The blue and mottled grey limestone here noticed has an extensive range of distribution all along the northern face of the Himalayah chain abounding in Ammonites, Terebratulæ, Belemnites, Zoophytes, &c., which have been met with in the valley of the Spiti by Dr. Gerard, at the head of the Ganges by Mr. Batten, and at Muctinath on the Gandaki river in Nepaul.[2] Several of the species have been determined by Mr. Sowerby not to differ from fossils of the English oolite. It is hardly necessary to add that this limestone has no other relation with the deposit which contains the fossil bones, besides contiguity of place.

The top of the pass, which is round and open, commands a view of the plain of Hīoondès. 'Right in front,' says Mr. Batten, 'stretched a dreary plain, shrubless, treeless, and houseless, terminated along its whole northern side, at a distance of about 20 miles, by a low range of rounded brown hills, utterly without shrub or tree or jutting rock, but very broken into ravines and perpendicular faces on their Southern side. Had there been heather instead of stone, it would have resembled a highland moor.' Its level was hardly anywhere lower than the pass. He further states his opinion that 'The Niti Pass

[1] Batten, *loc. cit.* [2] Colebrooke, As. Research. vol. xii. Append. p. xxi.

is only the highest point of the Tartaric plain, running up to the Himalayah peaks.'

From the details given by Moorcroft, it is very clear that the upper stratum of this great plain consists of a deep alluvial deposit—whatever the age of the alluvium may be—composed of beds of clay and gravel. He was struck, on entering the country, with the broad flat channels of the rivers, bounded by lofty steep banks, as contrasted with the narrow angular beds on the Hindostani side of the mountains, being precisely the shape that would be washed out by a torrent running through soft unconsolidated strata. His description further gives good reason to surmise that the alluvium rises in successful steps like the parallel roads of Glenroy. He mentions broken ground with ravines near Dhapa, rising into pyramids and buttresses, 'bearing no unapt resemblance to ruined castles and fortifications in piles above each other.' A ravine near the Tiltil river yields a section of beds of indurated clay and gravel above 300 feet in elevation; the heights are broken into all manner of fanciful shapes, spires, buttresses, &c., the sides being excavated into habitations. There is but little variation from the above in his account of the country between Dhapa and Gortope, or between the latter place and the Manasarovara Lake, except at Tirthapuri, where he states that 'steep craggy limestone rocks in a state of decomposition immediately overhang it (the village). Still higher, and losing their heads in the clouds, are pointed mountains, which from their brilliant whiteness appear to consist of chalk, covered here and there with a layer of yellow ochre.' Near this spot he describes, in very characteristic terms, an enormous bed of travertine, forming a table of about half-a-mile in diameter, deposited from hot springs now in operation. At Kienlung he met with other great travertine deposits, perhaps not exceeded in extent by those hitherto observed in any other part of the globe. 'The vast walls and masses of rock which have been formed by the action of hot springs in this neighbourhood show an antiquity that baffles research and would afford food for sceptics.'

So much for the general geological features of the Hīoondès plain. Of the particular beds which yield the fossils we have no accounts, besides the meagre details which may be gleaned from the Bhoteah merchants, who describe them as occurring in broken ground with ravines, upon the surface of which they are seen projecting or strewed over patches where the earth has been washed away by rills formed by melting snow. The specimens have rarely any of the matrix attached to them, but where it exists it is usually of coarse sand or gravel, agglutinated by a calcareous paste which effervesces strongly with the mineral acids.

Judging from the quantities which find their way to Almorah, the fossils are by no means scarce. They are rarely seen entire, consisting generally of fragments three to six inches long; sometimes the contents of a collection are nothing but bits of bone hardly an inch long. They usually present a clean and sharp or splintery fracture, wearing the appearance of having been fragmented after the mineralization was complete. They vary greatly in the amount of fossilization, and, consequently, in specific gravity. The infiltrated mineral in most cases is carbonate of lime. The specimens adhere more or less to the tongue. In some of them the cancellated tissue has the cells entirely filled with the infiltrated mineral; in others the cells are empty. It is rare to see any tinge of iron about them, a character so prevalent in the Sewalik fossils of the arenaceous beds. One class of them has very much the appearance of bleached bones, with the fracture also white; their fossil character resting on a core of crystallized carbonate of lime and the increased specific gravity. In another class the specimens yield a dark blue fracture, and weather with very much of the greyish white leprous appearances which chalk fluids exhibit. They effervesce strongly with nitric acid, and treated with a weak solution of it, the greater portion of them dissolves; they retain few or no traces of animal matter.

Our materials for the elucidation of the species are but scanty. They are: first, a set of specimens in Captain Cautley's collection at Suharunpoor, received from Captain Corbet of Almorah; second, specimens received from Mr. Batten of Kumaon; third, specimens procured from a Bhoteah merchant, said to have been collected by himself on the Hīoondès; fourth, Pl. III. of Royle's 'Illustrations,' which contains some figures of fossil bones procured from the northern face of the Himalayahs by Captain Webb and Mr. Traill.

Rhinoceros Remains.[1]—These are, fortunately, very decisive. Fig. 3, Pl. III. of Royle's 'Illustrations,' represents the greater portion of a tooth evidently derived from a Rhinoceros, and probably the fifth or sixth molar left side of the upper jaw; but this is a point not to be determined by the figure, and we have not yet had access to the letter-press relating to it.

The next specimen is a fragment in Captain Cautley's collection, consisting of the left half of the body, with nearly the entire ala of the atlas or first cervical vertebra of a Rhinoceros. The upper and lower articulating surfaces are complete, and the bone is so characteristic as to leave no doubt about its identification. There is one remarkable circumstance about it, viz. that there is no hole for the passage

[1] See Plate xv., figs. 3 to 11.—[Ed.]

of the vertebral artery, the transit of that vessel to the head having been outside, and not through the bone. But this is merely an abnormal variation in the individual nowise affecting the species. The bone differs somewhat in form from that of the Indian Rhinoceros and is smaller, indicating a distinct species.

A second specimen in my possession happens also to belong to the left side of the atlas of a Rhinoceros. It shows more of the body but less of the ala than the other, and has the arterial hole in the usual position. The form of the bone and size confirm the distinctness of species indicated by Captain Cautley's specimen.

A third specimen is fortunately also very characteristic. It consists of a fragment of the left temporal bone, showing the posterior half of the zygomatic arch, the entire glenoid articulating surface, the external auditory foramen, a portion of the petrous bone and part of the temporal fossa. The styloid and petrous apophyses are broken off. It appears to have belonged to rather a young animal, as the commissure between the base of the zygoma and the petrous bone is not completely ossified. The fragment adheres to the tongue, and is but imperfectly fossilized. The characters yielded by it bear out the difference of species, indicated by the other specimens, between the Indian Rhinoceros and the Tibet remains. The glenoid articulating surface—a very characteristic structure—has a different outline from that of the Indian animal; the base of the zygomatic process has less vertical height in proportion, and the dimensions are somewhat less.

The collections contain other fragments referable to the Rhinoceros, but too much mutilated to afford any good character for description or comparison. There are no traces of any other Pachydermatous animal; but Elephant remains will probably be found hereafter, when the ground is well examined, if they have not been already met with.[1]

It is a point of much interest as regards the general bearing of the inquiry, to determine whether these Rhinoceros remains differ specifically or not from the fossil species of the Sewalik range; but the available materials, in both cases, are too imperfect to warrant any safe conclusions on the subject. It appears sufficiently clear, however, that the Tibet fossil species differ from the existing Indian Rhinoceros.

Ruminant Remains.—These are the most abundant in species and in the numerical ratio of specimens. Fig. 1, Pl. III. of Royle's 'Illustrations,' represents a very perfect cranium

[1] Vide M'Clelland's Kumaon Inquiries, quoted above.

DESCRIPTION OF PLATE XV.

MERYCOPOTAMUS DISSIMILIS, FOSSIL RHINOCEROS OF NITI PASS.

Figs. 1 and 2. Represent the palatal and upper surfaces of the fragment of a young cranium of *Merycopotamus dissimilis*, from Burmah, sent by Dr. Oldham to Dr. Falconer. The figures are copied from drawings made by Mr. Dinkel for Dr. Falconer, and are one-third of the natural size. The palate surface shows the two last premolars and the two first true molars: *a*, cavity for anterior lobe of cerebrum; *b b*, frontal bones; *c c*, foramen in centre of frontal bone; *d d*, nasal bones; *f*, suture between nasal and maxillary bone; *g g*, maxillary bones. (See page 147.)

Figs. 3 to 11. Fragments of fossil *Rhinoceros* bones from the Niti Pass in Tibet, one-fourth of the natural size. Copied from drawings by Mr. George in Plate LXXVI. of the Fauna Antiqua Sivalensis. Figs. 3, 5, and 8 represent a fragment of the scapula, including the glenoid cavity and coracoid process; fig. 4 is a fragment of the left humerus near upper end; figs. 6 and 7 represent another fragment of a humerus; and figs. 9, 10, and 11 show a fragment of the lower end of a femur. The specimens are in the British Museum. (See pages 177 & 517.)

Fig. 1.

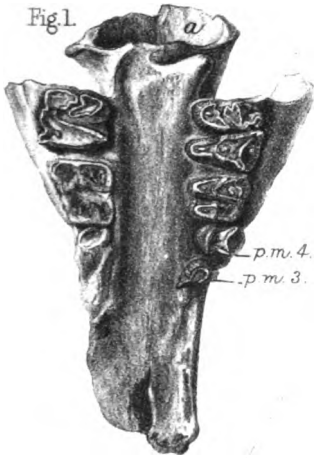

Fig. 2.

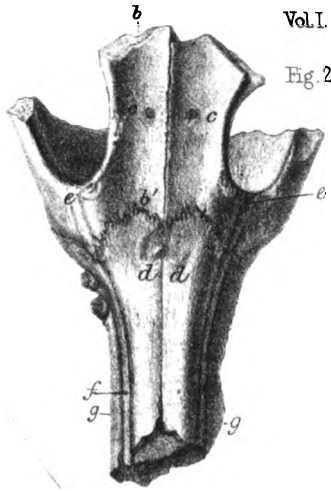

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

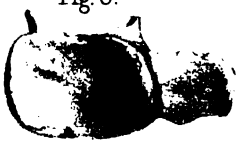

Fig. 9.

Fig. 10.

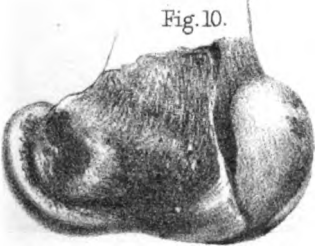

Fig. 11.

Dinkel & George del. J. Dinkel lith. W. West. imp

1, 2. Merycopotamus dissimilis, from Burmah.

of a ruminant with the pedicles of a couple of horns attached to the frontal. The saliency of the occipital crest, the sweep of the parietals and the position of the horn pedicles show that it belongs to the Cervine group of the family. But not having the letter-press to refer to, and in ignorance of the scale of dimensions on which the figure is drawn, it were useless to hazard or guess about the affinities of the species.

Fig. 2 of the same plate represents the left line of molars of the upper jaw of a ruminant. Judging from the figure, which shows no internal pillar between the barrels of the molar, the specimen belongs to the Caprine group.

In Captain Cautley's collection there is a specimen of the articulating head of the lower end of a femur of a bovine species. The dimensions fore and aft, between the articulating extremities, are six and a-half inches, exactly equal to the corresponding measurement of a full-sized wild buffalo (*B. Arna*) killed in the Shahjehanpoor forests. The existing Yak of Tibet is a much smaller animal. Another specimen in the Suharunpoor collection is the fragment of a scapula, corresponding in size with the femur. There are numerous other fragments of ruminant remains in the Suharunpoor collections, but none of them sufficiently characteristic to merit mention, except the detached core of a twisted sheathed horn belonging to some member of the Caprine group. The horn which it bore must have been twisted on its axis, like the 'Markhor' wild goat of the Baltistan Mountains (Little Tibet), a large and undescribed species.

There are no remains in the collection which can safely be referred to other mammiferous families except a solitary and detached Hyæna tooth procured from the Bhoteah merchant. It appears to be the third molar of the upper jaw, and is of large size. The whole of the specimens of this set are very much fragmented. They are white and have a very recent appearance, but they have lost their animal matter, have a considerable specific gravity, and the tubes of the cylindrical bones are occupied by crystallized cores of carbonate of lime, affording strong presumption of their being honest fossils. The Hyæna molar in question has the pipes of the fangs and the centre of the tooth filled with a nest of calcareous crystals.

This concludes what specially regards the determination of the fossils. It is very evident that the list is incomplete, for on a tract which could afford sustenance and a climate suited to the Rhinoceros a great variety of species might be expected. In what follows we put aside the consideration of the others, and address ourselves to the Rhinoceros.

The Steppe of Hioondès has been shown by Captain Webb to be upwards of 15,000 feet above the sea, close on the limit of perpetual snow; it is bounded on one side by the Himalayah Mountains, and on the other by the Kailasa range, of enormous height, some portions being, on a rough approximation, 30,000 feet above the sea. The tract, in the emphatic language of Batten, is shrubless and treeless—a vast waste supporting a few furze bushes and a sprinkling of the most Alpine vegetation; and the climate is one of Polar severity.

It is very certain that no Rhinoceros of the present time could exist for a day in such a habitat; and if we suppose the Tibetian species to have been clothed with a dense fur, like the Siberian species the carcase of which was brought to Pallas from latitude 64° on the banks of the Lena, still the tract could never have subsisted it, for although it has been urged by Dr. Fleming that the simple analogy of anatomical structure in the living species is not sufficient to guide us to a conclusion, or even a conjecture, as to the habits, geographical distribution, or food, of extinct species, so clearly shown in the lichen food of the Reindeer, still there is a limit to the force of this objection, and it only applies to certain cases. In the case of the Rhinoceros the incisive teeth are deficient in number, and the greater portion of them rudimentary in form and even deciduous. It may, therefore, be very safely predicated of all the species, fossil or existing, that they could never subsist by browsing on a herbaceous vegetation; they want the *nippers* which enable the horse and ruminants to subsist on low grass; and their food must either be derived from large reeds, shrubs, or trees, none of which are now found in Tibet.

The Siberian Rhinoceros remains are found on the shores of the frozen ocean, under conditions of climate more severe than those of Tibet; and it has been shown by Lyell how these remains might have found their way by changes in the physical geography of Siberia, by transportation in ice blocks, and by periodical migrations. But these conditions will not apply to the Hioondès; the Rhinoceros could neither have migrated to its mountain-locked plain, from the side of Hindostan by the passes, where men and goats can hardly find their way save by the artificial aid of scaffoldings, nor is it apparent how the bones could have been transported to their present resting place from a higher tract.

The only explanation of the case that suggests itself, which appears admissible, is a depression of the plain of the Hioondès to a much lower level than it has at present; and to clothe it with a vegetation resembling that of England now,

which, on the supposition that the Rhinoceros was not a migratory visitor but a permanent resident of Tibet, and clothed in a warm fur, is perhaps the utmost limit that could safely be conceded for its habitat. The plain of the Hīoondès would require to have been not higher than 7,000 or 8,000 feet above the level of the sea. The mean level of the Hīoondès which is known at Dhapa to be 15,000 feet, and estimated to be not much less than 17,000 near Manasarovara, may be considered as 16,000 feet. To reduce it, therefore, to the circumstances above inferred would involve the consequence that the northern face of the Himalayahs and (as elevating movements are nowhere known to be confined to narrow belts), probably a considerable portion of the chain itself, have been elevated 7,000 to 8,000 feet since the tract was tenanted by a species of Rhinoceros and several ruminants allied to existing species.

There are unquestionable proofs on the southern side of the chain that important elevations have taken place within a very late period, geologically speaking. The Sewalik formations are continuous with the Himalayahs, constituting in physical confirmation but the outermost belt of the chain. They bear, in fact, the same relation to the southern face that the Steppe of Hīoondès does to the northern. The fossiliferous strata attain a height of about 3,500 feet above the sea, and some parts of the belt about 5,000, the plains at their foot being about 1,000. These strata have not only yielded numerous extinct mammalia, but, besides Quadrumana and Camels, they have been shown to contain the remains of at least two existing species of Crocodile, viz. the Magar and Gharial, so common all over India; and the fluviatile shells (to which the testaceous remains are limited) have been pronounced by Mr. Benson not to differ specifically from recent types, common in the northern part of Hindostan.[1] This would show the upheavement, beyond all question, to date, geologically speaking, *since the commencement of* the present order of things; and if so grand a movement has occurred on the southern side of the chain within a late period, there is no reason why a similar upheavement should not have taken place on the Northern face.

Mr. McClelland has found proofs that a movement of elevation has taken place in the opposite prolongation of the chain in the valley of the Brahmapootra, in a marine deposit of considerable height abounding in shells on the Kasia hills. We are not informed what proportion of recent species has been found in these shells, and consequently, as to the age of the formation.

[1] Stated on the authority of Mr. Everest.

If it is admitted that there are good grounds for the belief that the plain of the Hīoondès has been elevated several thousand feet within a late period, it is necessary that we should consider what further consequences are involved in the supposition, and it will be evident that the entire line of mountains from the Lake Manasarovara to the southern bend of the Indus near Gilgit, in the parallel of Attock, must have partaken in the movement. For as the course of rivers from Manasarovara is due west, through a long intramontane tract, had the Hīoondès been 7,000 feet lower than it is now, and the western prolongations of the river beds not been proportionally depressed, the waters would have been held up, and we should have traces of vast lacustrine formations somewhere along the course of the Sutlej and Indus in Ladakh, which, so far as our information at present goes, does not appear to be the case. But as the great water-head of the western and eastern drainage of the Himalayahs is in the neighbourhood of Manasarovara, it is quite philosophical to imagine that the centre and greatest force of the upheavement was at the culminating point, and gradually decreased westward.

That upheavement of the southern face of the Himalayahs was in this manner is almost susceptible of direct proof. The Sewalik hills run west skirting the foot of the Himalayahs, beyond the western banks of the Jhelum; and the characteristic Sewalik fossils have been dug out of the strata between the Jhelum and Chenab, near Bimber, where they exist in abundance; they are also found between the Ganges and Gogra, and it is almost certain that the formation extends at least as far as the Gogra, giving a protraction in length of 270 miles, between the Jhelum and the Gogra. The greatest height of the fossiliferous strata is between the Jumna and Ganges, the elevation diminishing westward. It is, therefore, a matter for inference that the greatest force of the upheavements was at the culminating point, and was feebler as it extended westward.

It is a matter of much interest to determine whether these upheavements of the northern and southern faces were contemporaneous events. There do not appear any good grounds for coming to a satisfactory opinion on the subject, but there can be very little doubt that they belonged to the same geological era.

With these undoubted proofs (in the Sewalik hills) before us of comparatively late uprisings of the Himalayah mountains, it naturally occurs to the mind to inquire if the chain has been in a state of quiescence, as far as level is concerned, since the historical period, and if it is so in our own times.

The proof is embarrassed with immense difficulties in all mountainous tracts at a distance from the sea, which alone affords a certain standard for comparison; and this difficulty affects the central portion of the Himalayahs. But we shall endeavour to show that there are grounds sufficient for entertaining the presumption at least, that the Himalayahs are now undergoing a process of upheavements.

In Mr. Traill's excellent report on the Bhoteah Mehals, or region of the Tibet passes, occurs the following passage, which is so important to the point that it is given at full length.

'The paths to the passes' (the Mana, Niti, Juwar, Darma, and Beeans passes) 'continue along the upper part of the rivers above mentioned, till near the crest of the ridge, which is crossed in parts offering least difficulty in the ascent, and it is here only that snow is not met with during the season of intercourse. Roads of communication through the Himalayahs unite the passes from East to West, but they are passable during a few days only in each year, and are considered at all times dangerous by the Bhoteahs themselves. *Roads of this description formerly used are now impracticable, owing to the increase of snow.* The interior of the *Himalayah, except at the passes and paths in question, is inaccessible, and* APPEARS TO BE DAILY BECOMING MORE SO FROM THE GRADUAL EXTENSION OF THE ZONE OF PERPETUAL SNOW. *The Bhoteahs bear universal testimony to the fact of such extension, and point out ridges now never free from snow,* which, within the memory of man, *were clothed with forest* and afforded periodical pastures for sheep; *they even state that the avalanches detached from the lofty peaks occasionally present pieces of wood frozen in their centre.*'

Now these statements are of much importance, and their value is enhanced by the circumstance of their coming spontaneously from an unprejudiced inquirer. Mr. Traill attempts no explanation; he simply records the proofs and the universal belief that the zone of perpetual snow is descending lower. It is true that, before any conclusions could be safely drawn from them, the asserted facts will require to be verified and the observations extended, but they are at present sufficiently plausible to justify some speculations on the subject.

The circumstance of most weight is the assertion that pieces of wood are found frozen in the centre of the avalanches detached from the lofty peaks. Now it is very evident that this could only happen by a descent of the perpetual snow zone upon tracts where forests once grew, for it is difficult, if not impossible, to imagine how pieces of timber could at such enormous elevations be transported from below, so as to be

embedded high above in a mass of snow. But a descent, so to speak, of the snow zone could only occur in two ways, either by the line of perpetual snow being actually lowered to the level of the sea, or, supposing it to maintain a constant mean height, by an elevation of the mountain belt into the snow zone; either of which would produce, in appearance, the same effects.

Now, in regard to the first supposition of the lowering of the line of perpetual snow, the conditions which regulate the limits of that line are only very imperfectly understood, but it may safely be asserted that there are no grounds to believe, so far as our knowledge at present goes, that it oscillates more than the mean temperature of a place does; and the variation in this case does not extend beyond a few degrees of Fahr. Humboldt found that in the Andes, under the crater, the oscillation of the line of perpetual snow does not exceed thirty fathoms. In the Himalayah Mountains the present elevation of the line of perpetual snow is a huge anomaly, the plane being upwards of an English mile in excess of the amount yielded by calculation, with a formula for the latitude and height above the sea.[1] If, therefore, we suppose that the pieces of timber mentioned by Mr. Traill got enveloped in an avalanche by a lowering of the zone of perpetual snow, it would necessarily be implied that the plane of congelation was formerly more elevated, and would involve a still greater irregularity than the enormous extent at present ascertained, a position which it would be unphilosophical to admit, except on the strongest grounds.

On the second supposition, that the mean altitude of the plane of congelation is nearly constant, and that the mountains have been elevated into the snow zone, the instance of the enveloped timber would admit of two explanations; either that it belonged to the age when the Himalayah Mountains had their elevation increased by the Sewalik and Tibet upheavements or that the tract on which it grew had been subsequently raised up into the zone of congelation. That these mountains, before their summits attained their present elevation, were clothed with forests high up on the tract which is now covered with perpetual snow, is but consonant with the course of nature to suppose; and wood once enveloped in a snow bed would retain a freshness unimpaired for countless ages; we might, therefore, in a piece

[1] Perpetual snow level Niti Pass, Lat. 31° . . . . Feet 17,000
Calculated height of ditto by Professor Leslie's formula for Lat. 31° 11,253
Difference . . . . . 5,717 feet

of green wood, which descended from the higher peaks in an avalanche, light upon a remain which had a contemporaneous existence with the Sivatherium in Hindostan, or the Rhinoceros in Tibet; and it would be a matter of extreme if not insurmountable difficulty to determine to what period of the interval between these upheavements and the present time its envelopment in the snow should be referred.

The other circumstances mentioned by Mr. Traill, viz. that roads of communication from E. to W., between the passes formerly used, are now impracticable; that the zone of perpetual snow is gradually extending; and that ridges which, within the memory of man, were clothed with forest and afforded periodical pasture for sheep, have an obvious and important bearing on the question.[1]

[1] *Memoranda from Mr. Edgeworth, extracted from Dr. Falconer's Note-book.*—'1. On the Vishnoo Gunga, between Bhadra Nath and Pundoo Kesur, there is an artificial mound, at a place called Kutlean Kotee, which the Puharees say is the remains of a large hill city, that became deserted in consequence of the increased cold or descent of the snow zone. Charcoal and remains of pottery are found in it, and Edgeworth says the mound is, beyond all doubt, artificial. 2. There is a current tradition that formerly there was a straight path between Bhadra Nath and Kedar Nath, which has become impassable, so that a detour of several days is now necessary.—3. There was formerly a pass up the Bhillung river, which led into Tibet. It was last crossed more than fifty years ago, during the Goorka first invasion. Since then an attempt was made to cross it, but the party, of whom Edgeworth's informant was one, were struck with snow-blindness and nearly lost, so that they had to return.'—[Ed.]