# 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 hār' 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 hār* 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.

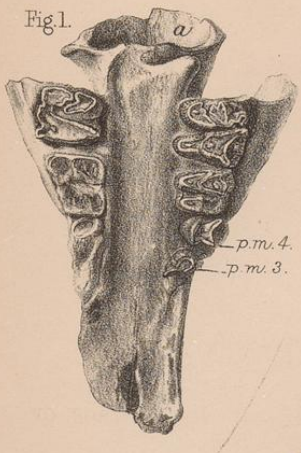


Fig. 2.

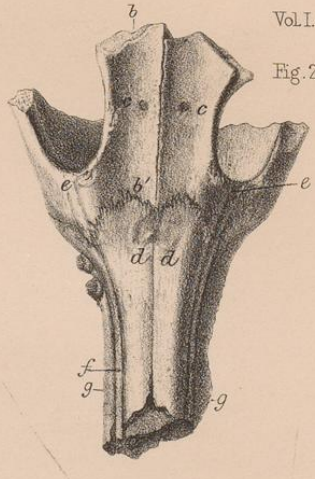


Fig. 3.

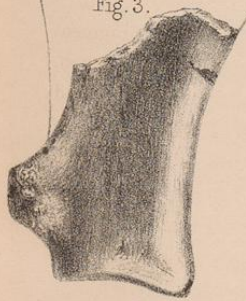

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

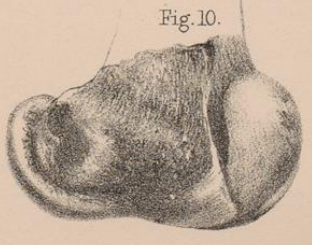

Fig. 11.

Dinkel & George del. J. Dinkel lith.

W. West imp.

1, 2. Merycopotamus dissimilis, from Burmah.
3 to 11. Fossil Rhinoceros, from Niti Pass, in Tibet.

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 Hīoondès 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 Hīoondès; 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 Hīoondès 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

| | Feet |
|---|---|
| [1] Perpetual snow level Niti Pass, Lat. 31° . . . | 17,000 |
| Calculated height of ditto by Professor Leslie's formula for Lat. 31° . . . . . | 11,253 |
| Difference . . . . . | 5,747 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.]