

are not worn it is not improbable that they did not come into use till late in the life of the animal, when their relative position may have become like that of the teeth in the first mentioned jaw. Otherwise the jaw must have been set in such a manner as to admit the possibility of the attrition of the vertical external surface of the ramus in the one or other of the rows of palatine teeth. The presence of these lateral teeth in the lower jaw of the Gondwana lizard would seem to lend countenance to the probability of its being distinct from its European congener.

Observations on the Ossiferous Beds of Húndes in Tibet. By R. LYDEKKER, B.A., F.Z.S., Geological Survey of India.

It not unfrequently happens that scientific questions which have been apparently settled once for all, by the acquisition of new facts in relation to them, are subsequently again brought on the tapis, and the original decision either reversed or shown not to rest on such a sure basis as was at first supposed. Such reversals or modifications reflect no discredit on the propounders of the older views, which in many cases were the only legitimate conclusions to be drawn from the facts at command.

An instance, where there is a probability of the original conclusions drawn from them being liable to modification, is afforded by the case of the bones of fossil mammals brought across the Niti pass, from the plains of Húndes in Tibet.

A paper from the pen of the late Dr. Falconer, written probably as long ago as the year 1839, but never published till 1868, when it appeared in the posthumous "*Palæontological Memoirs*"¹ of that distinguished palæontologist, gives all the information then known in regard to the occurrence of these bones in the Húndes (Hicoondes) plains. In that paper it was clearly demonstrated that these fossil bones were brought from beyond the Niti pass; the strata whence they were obtained were, however, still unknown. Of the bones at that time known, some were stated to belong to various forms of ruminants, among which a bovine animal, and a goat, whose horns were twisted after the fashion of the living Himalayan markhoor, were particularised. Other bones were determined to belong to a species of rhinoceros; while a single tooth was referred to a hyæna.

At a later period some of the best preserved of these and other bones from the same locality were figured in the "*Fauna Antiqua Sivalensis*" where they are referred to a rhinoceros and a horse.² Other remains from the same deposits were also figured by Royle; notably the hinder portion of the skull of a ruminant which will be more fully noticed below.³

From the occurrence of the bones of a rhinoceros it was inferred by Dr. Falconer in the paper quoted that the Húndes plain had been raised to its present enormous elevation subsequently to the time when the animals of which the fossil

¹ Vol. 1, p. 173.

² Pls. 76, 84.

³ "*Illustrations of the Botany, &c., of the Himalaya mountains,*" pl. III., fig. 1.

remains are found flourished, since he thought it impossible that such an animal could have existed at an elevation of 15,000 feet, which is the present height of the plain. It has subsequently been considered possible that these fossil bones corresponded in age to some of those obtained from the Siwaliks of the outer Himalaya.¹

At a later period other bones were obtained by General Strachey,² who inferred that they were derived from "the great undisturbed diluvial deposits filling the valley of the Upper Sutlej to a depth of 3,000 feet, and forming the wide plain of Húndes." Notwithstanding this determination, General Strachey goes on to remark that "there is no direct proof that these beds are marine, no shells having been obtained from them; but I think on the whole that the probabilities appear to be in favour of this plain having been a true sea-bottom rather than of having been occupied by a detached body of freshwater." It is then concluded that these Húndes beds must have been raised from the sea line to a height of 15,000 feet without the slightest disturbance of their horizontality.

Among the bones obtained by General Strachey, some were referred to *Equus* and *Hippotherium*; but it is very questionable whether the materials were sufficient for the determination of the latter. A skull was considered to belong to either a goat or a sheep, while a vertebra was referred to a rhinoceros. The other determinations are doubtful.

This has been the extent of our knowledge till quite recently, when Mr. Griesbach has briefly noticed the Húndes diluvial beds in the last volume of this publication.³ In that passage it is stated that fragments of mammalian bones were obtained from these horizontal deposits, whence it is inferred that the specimens previously acquired came from the same source. The very important observation is also made that these horizontal deposits rest (of course unconformably) upon highly tilted tertiaries, which are presumed to correspond with some members of the Siwalik series of the outer hills.

There being now very strong evidence to show that the fossil bones are obtained from the horizontal deposits, it becomes a very grave question whether Dr. Falconer's and General Strachey's conclusions, that the Húndes plain has been raised from a far lower level to its present elevation since the time that the animals whose fossil remains are found there existed, can be maintained. The main line of evidence from which this opinion was arrived was from the supposed impossibility of the existence of a rhinoceros on these barren plains, and this is no doubt a very formidable consideration. It is, however, on the other hand, extremely difficult, though not impossible, to imagine how these plains can, as Dr. Falconer supposes, have been raised from an elevation of 7,000 to 15,000 feet, without disturbing the horizontality of the diluvial deposits. Such an hypothesis, it appears to me, can only be adopted on the most incontrovertible evidence, and I shall proceed to enquire whether such evidence is forthcoming in this instance.

I shall first proceed to show that there is a great probability that at least

¹ "Manual of Geology of India," p. 651.

² "Quar. Jour. Soc.," Vol. VII, p. 306.

³ p. 91.

some of the mammals, which lived during the deposition of the Húndes diluvium, were such as now inhabit similar altitudes; while the question of the possibility of the existence of a rhinoceros at the same elevation will subsequently be touched upon.

The skull of a ruminant figured by Royle has been already alluded to, but may now be considered more closely. The specimen was obtained by Messrs. Webb and Trail from the Tibetan traders, and is said to be at the present time in the collection of the Geological Society of London. No reference is made by Royle as to what kind of animal the skull belonged. Dr. Falconer, however, stated¹ that it belonged to a member of the cervine group. This determination is entirely erroneous, as can be seen at once by a comparison of a deer's skull with Royle's figure. The specimen, without doubt, belongs to some member of the antelope family. I have made a comparison of the figure with the skulls of all the Indian members of this group, and I find that it differs very widely from all with the exception of the skull of the Tibetan *Pantholops hodgsoni*. The skull of that animal differs from the skulls of the Indian antelope and gazelles by the greater proportionate length of that portion of the skull which is behind the horn-cores; by the very distinct depressions on the parietals for the temporal muscles; and also in the exceedingly small size of the frontal foramina at the base of the horn-cores. The skull of *Pantholops* is further noticeable for the great lateral compression of the horn-cores, in which character it differs most markedly from the Indian black buck.

In all the above mentioned points the imperfect skull figured by Royle agrees so closely with the skull of *Pantholops hodgsoni*, that it is impossible to say, without the original specimen, whether the two do not belong to the same species, and it may be safely asserted that there is every probability that they belong to the same genus. This being so, I venture to propose for Royle's specimen the provisional name of *Pantholops hundesiensis*, from the place where the skull was obtained.² There is of course a certain element of uncertainty in determining the affinities of a fossil merely from the study of a figure, but the resemblances between the skull in question and that of *Pantholops hodgsoni* are so strong that they appear to justify the provisional assigning of the two to the same genus.

It thus appears, that, as far as can be determined, the bones of fossil mammals hitherto obtained from the plateau of Tibet may probably be referred to the following genera, viz.,—

Ruminants	(?) <i>Pantholops</i> . <i>Bos</i> or allied genus.
	(?) <i>Ovis</i> . <i>Capra</i> .
Perissodactyles	<i>Equus</i> (? a <i>Hippotherium</i>). <i>Rhinoceros</i> .
Carnivores	(?) <i>Hyæna</i> .

¹ *Loc cit*, p. 179.

² I may express a hope that this paper may meet the eye of some member of the Geological Society, who may be induced to search out the fossil skull in question, and compare it carefully with the skull of *P. hodgsoni*.

With regard to these genera, the first inhabits the highlands of Tibet only, being seldom, if ever, found below an elevation of 13,000 feet: it occurs abundantly on the Húndes plains. The genus *Bos*, in its original wide sense, is represented in Tibet at the present time by the yák (*Bison* or *Pæphagus*). *Ovis* and *Capra*, the latter in the form of the ibex, occur abundantly in many parts of the Tibetan region; while *Equus* is also a very characteristic Tibetan genus. As to the occurrence of *Hyæna*, I am somewhat doubtful as to correctness of this determination; but I see no reason why, since *Felis* occurs in Tibet, this genus should not formerly have had a similar range. As far, therefore, as these five genera go, there is no reason for supposing that their fossil representatives did not live at the present elevation of Húndes; while the first of them, if rightly determined, is strongly in favour of such a view.

There only remains the question of rhinoceros; and it may now be considered whether the evidence in favour of the deposition of the Húndes strata at a much lower level than their present one, as adduced from the presence of this genus, is so strong as was supposed by Falconer, and whether it is not counterbalanced by the evidence from the present position of the strata.

The improbability of a whole series of strata being carried up through an elevatory movement of many thousand feet, without the slightest disturbance of their original horizontality, has already been alluded to. The question may, however, be regarded from another point of view,—namely, the probable age of the Húndes diluvial strata.

In other parts of Tibet and the neighbouring regions of the Himalaya, there occur numerous instances of luustrine and diluvial strata, which, except in Káshmir, are always horizontal, and which have been generally referred to some part of the pleistocene period, but, perhaps, sometimes also contain representatives of a part of the upper pliocene. In many parts it has been also inferred on strong evidence that these strata are of pre-glacial origin. Again, in all regions of the Himalaya where lower pliocene and miocene strata are known, these have always been subjected to a greater or less degree of disturbance, and in Káshmir this disturbance has acted on strata which are either of pleistocene or upper pliocene age. Again the Húndes diluvial beds rest on highly-disturbed tertiary strata, which have been provisionally referred to some part of the Siwalik (plio-miocene) epoch.

Now the known fauna of the Húndes beds comprises (with the exception of the alleged occurrence of *Hippotherium*, which does not appear to me to rest on sure grounds) only living genera of mammals, all the extinct Siwalik genera being conspicuous by their absence; and I accordingly come to the conclusion, from this and from the foregoing conditions, that the beds in question are probably of pleistocene age, and almost certainly not older than upper pliocene.¹

¹ In previous papers, not having entered at any length into the fauna and position of these beds, I have followed the old lead of classing them with the Siwaliks. It may be objected that my inductions as to the genera of mammals not occurring in these beds are based upon insufficient grounds. The teeth of mastodon, however, so common in the Siwaliks, if they occurred in the Húndes beds, would be the most likely specimens to attract the attention of travellers and traders.

Assuming, then, the probability of the at all events partly pleistocene age of the Húndes beds, a very great difficulty presents itself if we suppose these beds to have been deposited many thousands of feet below their present elevation. We have seen reason to believe that the analogous strata in other districts of the Himalaya were deposited before the glacial period, but, as they are of pleistocene age, not very much before this epoch. Hence, on Falconer's hypothesis, the Húndes beds would seem to have been deposited shortly before the glacial period, at a time when the Himalaya was only half its present height. This lands us in the dilemma either that the great glaciation of the Himalaya took place when these mountains were only half their present height, which is in the highest degree improbable; or that these mountains were raised a height of 8,000 feet during the pleistocene period, immediately before the glacial epoch. It is very questionable, on this latter view, whether there could have been time during this period for such a gigantic upheaval, unless we assume it to have been a sudden one, which is extremely unlikely.

On the other hand, if we consider that the Húndes beds are of post-glacial origin, then we must assume either that the great glaciation took place at the low elevation indicated above, or that after this glaciation the Húndes plain was first depressed 8,000 feet, and then again raised to its present level.

On the only other possible hypothesis, namely, that the Húndes beds are of lower pliocene or upper miocene age, we are compelled to traverse the induction as to the age of these deposits, gathered from analogous deposits in the neighbouring parts of the Himalaya; and we are further confronted by the fact that the tilted strata, unconformably underlying the Húndes diluvial beds themselves, probably represent the lower pliocene and upper miocene.

We see, therefore, that there are unquestionably very serious difficulties in accepting the Falconerian hypothesis; and we may now proceed to consider the question of the possibility of the former existence of a rhinoceros on the Húndes plains. Dr. Falconer, in treating of the present physical conditions and climate of Húndes, observes: "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 Tibetan species to have been clothed with a dense fur, like the Siberian species, the carcass 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 single 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 in 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."

Now, assuming that the incisive dentition of the Húndes rhinoceros was

similar to that of living species, which it probably was, it may be freely granted that the animal was not such a close grazer as a horse or sheep.¹ To any one, however, who has seen a rhinoceros in captivity plucking off tufts of comparatively short grass with its upper lip and tongue, it would seem not impossible for the animal to have obtained a certain amount of sustenance from the short, dry herbage now found in Tibet; though I do not think it possible that the animal could have existed on vegetation like the present.

There is, however, another very important element which enters into the question, and that is that there are some indications that the climate of Tibet was probably at one time more genial and moister than at present, and that, at all events, far more water was present in the valleys than now.

The Húndes plain, at whatever elevation it stood, must certainly have contained a large lake, or series of lakes, at the time of the deposition of the mammaliferous strata; and there is, therefore, every probability that the borders of this lake were fringed with a reedy and bushy vegetation, as is now the case in such parts of Tibet, where marshy valleys occur, as in the valley of the Chang-Chenmo river. Again, since a great number of the lakes in Tibet show unmistakable signs that in place of having always been, as now, salt lakes with no outlet, they were once filled to a much higher level (40 feet in some cases) than at present, and that other vast lakes existed where there are now barren plains, it has been inferred that the climate of Tibet was formerly much milder and moister than at present.² Now, even at the present time, with the aid of artificial moisture, grain is grown at an elevation of 15,000 feet³ (the elevation of Húndes) in Tibet, and it accordingly seems that the want of moisture is one of the great elements of the present barrenness of the country. Hence it is only a fair induction to suppose that in former times the vegetation of Tibet, though of course never luxuriant, owing to the altitude, may once have been far more abundant than at present. The willow, poplar, tamarisk, pencil-cedar, and *Eleagnus* now forming the chief trees of Ladák, and some of which, according to General Cunningham, now thrive at an elevation of 13,500 feet, may not improbably in a moister and milder climate have had a greater development than at present, and may have grown at elevations where they are now unknown.

That a rhinoceros can live on the shoots and branches of kindred trees and bushes, together with grass, has been shown by Dr. Schmalhausen's researches on the composition of the vegetable matter found in the interstices of the teeth of the Siberian tichorine rhinoceros⁴. These researches have shown that the food of this animal consisted of the shoots and small branches of pines, larches, and birches, together with grass and heath.

¹ A horse, from having incisors in both jaws, is a closer grazer than a large ruminant like the ox; a small ruminant, like the sheep, however, in spite of the absence of upper incisors, can graze closer than the horse, on account of the smaller size of its bite.

² See Cunningham's "Ladak," p. 190. The author has shown that shells now found living only at an elevation of 11,000 feet are found fossils at an elevation of 15,000. This of course cuts two ways.

³ *Ibid.*

⁴ "Mem. Imp. Geol. Inst., Vienna," January 23rd, 1877.

A writer in the *Geological Magazine*¹ has lately shown that at the time the tichorine rhinoceros inhabited Siberia, the country at first enjoyed a far more genial climate than at present, and was probably covered with forests where all is now a barren waste. The animal was covered with a thick coat of fur and wool to withstand a certain amount of cold, but would seem to have been eventually swept away from these regions by the increasing cold of the glacial period and consequent barrenness of the country. That it did, however, live for a part of its time in an arctic climate is proved by the occurrence of its remains with the flesh and skin still undecomposed in the frozen soil of Siberia.

With this example before us, and seeing the probability that the plains of Húndes may formerly have enjoyed a more genial climate than at present, and a consequently more abundant vegetation, it does not seem to me to be entirely beyond the bounds of possibility that a rhinoceros may once have found the means of subsistence on these at present bleak and barren plains. The Húndes beds, as we said, judging from the analogy of very similar deposits in other parts of the Himalaya, were probably deposited before the last great extension of the glaciers, and we may thus imagine that it was this accession of cold that rendered the Tibetan plains uninhabitable for a time, since which they have never regained their warmer pre-glacial climate. Further, supposing that a rhinoceros did formerly inhabit these plains, it would not be necessary to assume that it lived there throughout the year, but rather that it was merely a summer visitor, and that during the colds of winter, which at such an elevation must always have been severe, it sought protection and food in the warmer valleys below.

There is, however, still another possible element in the case. Although we have considered it probable that any such elevation as that supposed by Strachey and Falconer has taken place since the deposition of the Húndes beds, yet the occurrence of a minor elevation since that epoch is by no means improbable. An elevation of 1,000 or 1,500 feet is a vastly different matter from the enormous elevations required by the above writers, and might have taken place with very little disturbance of the general relations of the country. If the Húndes plain were 1,500 feet lower than at present, during a warmer and moister epoch it would have unquestionably borne an abundant vegetation. The possibility of such a minor elevation is countenanced by the fact that the pleistocene lacustrine strata of the valley of Káshmir have undergone a considerable amount of disturbance.

Finally, it appears to me that in the face of the foregoing considerations, it would be wiser, at least for the present, to suspend our judgment, rather than to commit ourselves to the uncompromising assertion that the diluvial beds of Húndes were deposited at an elevation variously estimated from 8,000 to 15,000 feet below their present level.

¹ Mr. H. H. Howorth. "The Mammoth in Siberia." December 1880.