FAUNA ANTIQUA SIVALENSIS.

I. INTRODUCTION.[1]

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A.

INTRODUCTORY OBSERVATIONS—ANTIQUITY OF HUMAN RACE IN INDIA —ITS MYTHOLOGY—ANTIQUARIAN CONDITION OF INDIA BEFORE MAN—EVIDENCE AFFORDED BY ORGANIC REMAINS—HISTORY OF DISCOVERY OF FOSSILS IN INDIA.

THE antiquities and literature of the East have been, from its commencement, the special field of investigation to this Society, and to the parent institution in Calcutta. A rich vein has been opened, branching in a thousand ramifications, and fertile in results of the deepest interest. The human race has been traced farther back into time in the East than in any other quarter of the globe; and the tendency of all inquiries has been to show that the civilization of at least a large section of mankind first dawned in the valley of the Ganges. The language or the mythology, the arts and the sciences of India, have all been found more or less engrafted on surrounding nations, and even that civilization which we now boast of—which has shot so far ahead of the parent stock—may be followed back to a spring-head in India, whence it travelled westward through Egypt, and spread over Greece and Italy.

Nor is it remarkable that it should be so. Man, *cæteris paribus*, must have progressed most rapidly where most favourably placed in regard to the external conditions which regulate the increase of his race and the development of his social relations. Neither the valleys of the Nile, nor of the Euphrates, Tigris, or Oxus, in extent and fertility together, or in the richness and variety of their productions,

[1] This introduction is mainly based on the manuscript of two discourses delivered by Dr. Falconer before the Royal Asiatic Society of Great Britain, on June 1 and 8, 1844, a very brief abstract of which only appeared in the Journal of the Society (No. xv. Pt. i. p. 107). Part B., however, was probably written in India some years before; and Part C. has been, in a great measure, constructed by the Editor from private letters written by Dr. Falconer, between the years 1844 and 1847. This will account for the designations of several of the fossils being different from those given in the published abstract.—[ED.]

can admit of comparison with the valley of the Ganges. Sugar, rice, cotton, and the golden fleece of the silkworm, with numerous other industrial products, have from the remotest antiquity been the common staples of the country, and have been brought forth in such surprising abundance, that other less-favoured nations could only embody the idea by conceiving that the sands of India were strewed with gold. So far down even as the days of the Roman empire, we find Pliny describing sugar as a kind of honey which exuded naturally from reeds in India, like a gum, but assuming the form of a crystal. To benefit suitably from such favoured circumstances, we find that the Indian variety of the Caucasian branch of the human family has the most perfect development of that physical conformation which is observed to be associated with the highest capability for mental improvement.

It is beside my object, on the present occasion, to do more than barely allude to this line of research and its bearings, as introductory to the subject I am desirous to bring before you this evening, which is to take up the antiquarian history of the animal races of India, back from the epoch where we lose all indications of mankind.

There is a point up to which we can follow man back through the records of language and art and the shadowy indications of mythology and tradition, but beyond which we cannot go. Every trace of the human race then fails us; and if we wish to dive further into remote antiquity we have to fall back on another order of antiquarian research, of the highest interest, resting on monuments and inscriptions constructed by nature, more enduring than the colossal sculpture of Elephanta, as legible as the scroll on the Bactrian coins, and infinitely more certain in their indications than language, tradition, or mythology.

The *Colossochelys Atlas*, or gigantic fossil tortoise of India, discovered by Captain Cautley and myself, supplies a fit representative of the tortoise, which sustained the elephant and the infant world in the fables of the Pythagorean and Hindu cosmogonies. It is a point of great interest to trace back to a probable source a matter of belief like this, so widely connected with the speculations of an early period of the human race.

You are aware that at the present day every climate and every great division of the globe are characterized by their peculiar race of animals. So constant are the laws which regulate this distribution that, if told of the existence of certain species, we can predicate with confidence regarding the temperature of a country, and the general character of the vegetation with which they are associated. Nature, uniform in the operation of her laws, has followed the same

order in past time as we observe at present, and thrifty in her handiwork, has not merely created and extinguished numerous successions of beings, but at the same time left indelible records of each in the strata which constitute the surface of the globe. We can trace by their fossil remains the different faunas, from the oldest up to the existing creatures. The further we go back into antiquity, we find the animated races to differ more and more from what they are at present; and as we descend toward the human period, we detect a progressive approach to the existing kinds of beings. The order of succession has been followed out in Europe by the concurrent labours of a vast number of observers, with wonderful precision; and the changes in the animals have been shown to have been accompanied by corresponding alterations of climate, or of other physical conditions. We have the most certain proofs that England had at one time the heat of the tropics with a similar vegetation and tropical animals; and there are the strongest grounds to believe that at a later period it was either covered with glaciers or sheeted over with the drift-ice of an Arctic ocean.

The smaller number of observers in tropical countries has necessarily led to our knowledge in regard to them being infinitely less advanced than as regards Europe. But much has been done lately in America and in India. Passing over more remote periods, we shall now proceed to consider what was the condition of the animated creation in the latter country during the period which preceded the appearance of the human race upon it. When the plains of Europe fed the Mammoth, the Elasmotherium, and the Rhinoceros, and America the Mastodon and the Megatherium, what were the kinds of animals that then peopled India?

The evidences employed in inquiries of this nature, in lieu of the monuments and inscriptions used by the ordinary antiquary, are the fossil remains of extinct animals found in the newer strata of the earth. But before entering upon them it may be well to say a few words regarding the method upon which the evidence is worked out. Every organised being is made of a number of parts, which have a definite and constant relation to each other and to the common functions of the aggregate form. For instance, a predaceous animal like the tiger can only live on flesh; its alimentary apparatus is constructed to digest this kind of food; its jaws and teeth are formed to act like a scissors in cutting it up; its claws to seize its prey and tear it to pieces; its extremities are built to enable it to spring; and in connection with the rest, it has an instinct which leads it to lie in wait, or come stealthily on its victim, and so on throughout its system. On the

other hand, an herbivorous animal has its teeth and jaws constructed to act as a grinding apparatus; its extremities are not required to seize prey, and are, therefore, formed merely to sustain the body, and for speed to enable it to escape from danger; and so on with corresponding modifications throughout its organisation. In short, every part of an animal bears an invariable relation to every other part, and is of itself an index to the general form. The bony skeleton constitutes the basis of the construction. When, therefore, fossil bones are detected in the strata of the earth, each fragment is a monument of the existence of a former race of animals, and every tooth or articular surface a distinct inscription, as it were, in regard to the special character of the animal from which the bones were derived.

The first notice of the occurrence of fossil bones in India is contained in that excellent compendium of the history of the Moghul and Pathan emperors by Ferishta. We are there told, that under the reign of Feroz Shah the Third, in the year 1360, 'The emperor on his return to Delhi, in the month of Rujub (May 1360), was informed that near Hirdar[1] there was a hill out of which issued a stream of water called Sursooti, running into the Sutlej, and beyond a watercourse called Selima. It was stated that if a great mound between these two streams were dug through, the water of the Sursooti would flow into the Selima, and thence through Sirhind and Mŭnsoorpoor on to Sunnam, and that the supply of water would be perennial; whereupon the emperor proceeded in that direction, and having ordered 50,000 labourers to be assembled, he caused the eminence to be dug through, so as to form a junction of the two streams. In course of the operations bones of elephants and men were discovered in the unbedded mound. Those of the human forearm measured three yards. Some of the bones were petrified, while others were still in the condition of bone.[1]

The bearing of this passage upon Indian palæontology was first observed by General Briggs. The locality Hirdar refers to a place in the Sewalik hills, where abundant fossil remains have been found since.

Captain Webb, in his admirable survey of heights of the Himalayah mountains, was the first to prove the existence of fossil bones in that chain. They are called 'Bijli ki har,' or 'lightning bones' from their supposed origin, and are found in the elevated plain of Tibet behind the sources of the Ganges. They are collected by the inhabitants, and exported to the plains as charms. In this way they were brought to the notice of Captain Webb, who communicated them to Mr.

[1] *Perwar*, according to Prinsep.—[Ed.]

Henry Colebrooke, by whom they were sent to Europe. They are referred to in Dr. Buckland's 'Reliquiæ Diluvianæ,' but no detailed account of them has yet been published. The very important inferences connected with these remains in regard to the elevation of the Himalayahs will be noticed hereafter.

The next notice of fossil remains in India was by Mr. Crawfurd, who during his embassy to Ava, in 1826, discovered a deposit of silicified bones of large animals along the banks of the Irrawaddi, consisting of remains of Mastodon, Rhinoceros, Hippopotamus, Crocodiles, Deer, and other animals. Such of the species as admitted of identification were described by Mr. Clift in the 'Geological Transactions,' and attracted great interest at the time. Mr. Clift established the important fact of the former existence of two species of Mastodon peculiar to India.

The next discovery of fossil bones was made by Captain Cautley and myself, in 1831, in that range of tertiary hills skirting the foot of the Himalayahs, to which we have applied the name of Sewalik hills.[1] They were at first found sparingly, but in increasing numbers up to 1834, when through information supplied by a native rajah, Lieutenants Baker and Durand were guided to a tract where they were found in the utmost abundance near the sources of the Sursooti river. Early in the investigation, in 1835, an account was published of a very remarkable animal, called the Sivatherium, which awakened attention to the subject in India generally; and similar remains were found in the valley of the Nerbudda by Dr. Spilsbury, and in Perim Island in the Gulf of Cambay by Dr. Lush and Lieut. Fulljames. It is interesting to keep these facts in mind, as Perim Island, the Irrawaddi, and the western part of the Sewalik hills, form as it were three points in a great triangle spread over the whole width of India, showing that the same ancient race of animals formerly extended over the continent.

[1] MSS. note written by Dr. Falconer, in 1832. 'Fossil bones were first discovered by Lt. Cautley. He met with a single piece which was so imperfect that he did not imagine it to be a portion of animal remains. On going to the locality some years afterwards, I met with a few fragments which satisfied me of the existence of fossil bones in the lower hill formation. They consisted of portions of a testudinous shell, a vertebra of one of the reptilia, &c. I met also with some laminar pieces of crystalline carbonate of lime, simulating greatly the appearance of a compressed bivalve shell, which subsequent examination proved them not to be. A slight notice of the circumstance was given by Dr. Royle in the Journal of the Asiatic Society (vol. i. p. 96). The fragments up to this date were so imperfect, that little beyond conjecture could be made out of them, but during last cold weather, on a visit to the Timli pass, I found a fragment of a well-marked testudinous remain, and since then Lt. Cautley has been so fortunate as to discover several other portions of bone, which set the matter at rest.'—[Ed].

Before entering on the particulars of the fauna, it may be well to refer briefly to the geographical relations and the geological structure of the Sewalik hills.

B.

ON THE GEOGRAPHICAL POSITION, PHYSICAL CHARACTERS, AND GEOLOGICAL STRUCTURE OF THE HYSUDRO-GANGETIC PORTION OF THE SEWALIK HILLS IN NORTHERN HINDOSTAN.

By 'Sewalik hills,' it is here meant to designate that range of lower elevations which stretches along the SW. foot of the Himalayah mountains, for the greatest portion of their extent from the Indus to the Brahmapootra, where those rivers respectively debouche from the hills into the plains of India. The name Sewalik,[1] or Scevalik, has hitherto had no definite application, nor has it been universally adopted by the geographers of India. By some it has been restricted to the tract between the rivers Jumna and Ganges; by others to that between the Ganges and Gogra forming the plain-ward boundary of the province of Kumaon; and by others to that between the Gogra and Gunduck forming the northern boundary of the province of Oude; while in Arrowsmith's Map of 1816, and in the 'Grand Trigonometrical Survey Map,' the designation is nowhere applied. We have resorted to the term Sewalik as geognostically preferable to Sub-Himalayahs, which were equally applicable to a range at the northern as at the southern foot of the great chain: the ambiguity and inconvenience of a term of this sort having been felt in the restricted use of 'Sub-apennine.' Sewalik is also convenient as a geographical designation; and its having been applied by various authorities to different portions of one range, otherwise without a name, is a sufficient reason for its adoption for the whole of that range.

Special object of the Memoir.—The object of this memoir is

[1] Sewalik, or Scevalik, derived from Siva, or Mahadeo the Hindoo God: these hills, as well as the Himalayahs being connected in Hindoo mythology, in various ways with the history of Siva. Major Rennell (Memoir, p. 72) applies the name to the tract from the Sutlej to Hurdwar (p. 233).

Rennell, describing the Ganges (3rd edit. 1793, p. 313), says, 'At Hurdwar it (the Ganges) opens a passage through Mount Sewalick, which is the chain of mountains that borders on the level country on the north of the province of Delhi. Even Sewalick would be deemed a lofty range, but for the presence of Mount *Himmaleh* or *Imaus*, which rises above it, when viewed from the plains of Hindostan.'

Idem, p. 368. 'Sirinagur is situated on an exceedingly deep, and very narrow valley, formed by Mount Sewalick * the northern boundary of Hindoostan on the one side, and the vast range of *Himmaleh* or *Imaus* on the other,' &c.

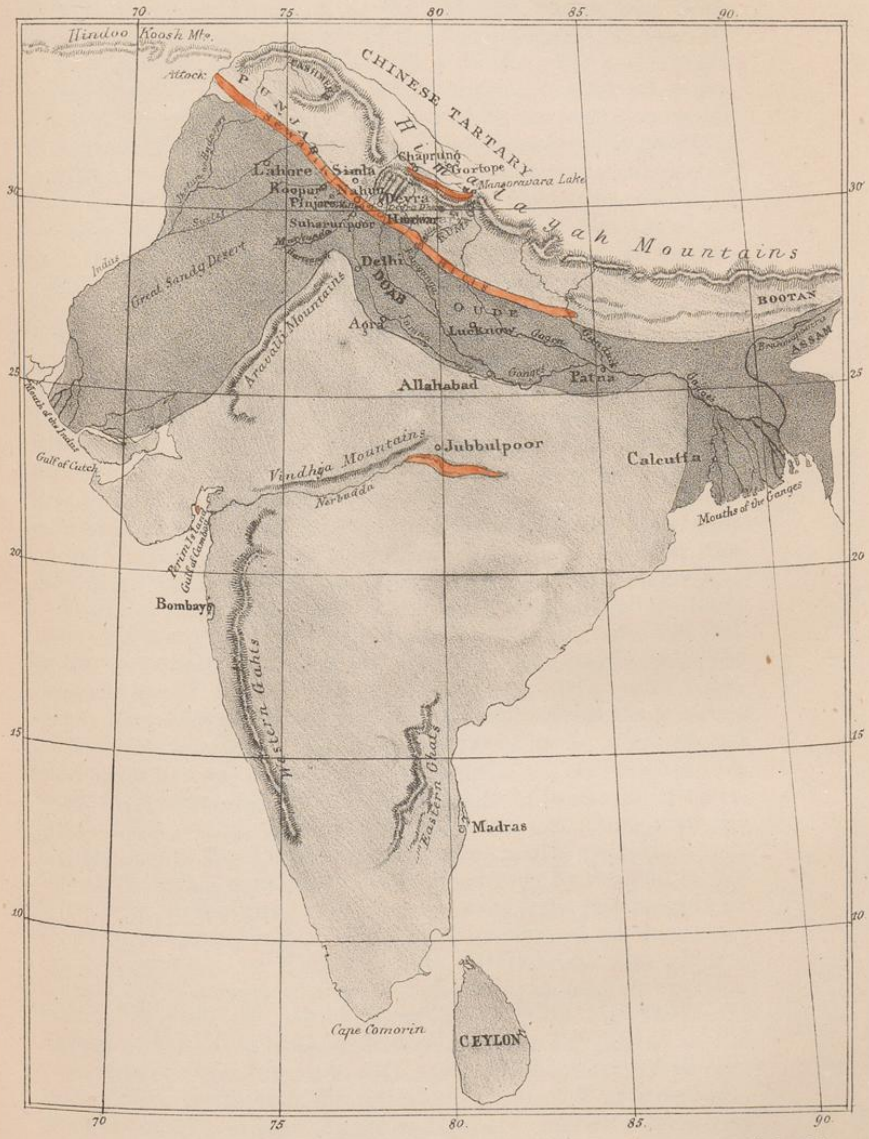
* Sewalik is the term according to the common acceptation; but Captain Kirkpatrick proves, from the evident etymology of it, that it should be *Sewa-luck*.—Rennell, p. 368.

DESCRIPTION OF PLATE II.

Map illustrating Dr. Falconer's Observations on the Geology of India (p. 28). This map is reduced from a larger one which Dr. Falconer had coloured, and to which he had affixed the following explanatory note. The different shadings correspond to the colours in the original.

'The great mass of *light shading* represents the supposed *insular* form of the continent of India at an early period of the Tertiary epoch, the island forming a sort of triangle, of which the eastern and western Ghats formed the sides and the great Vindhya range the base, with an irregular patch of mountainous country stretching north forming the Aravalli range.

'The *dark shading* represents the plains of India, forming the valley systems of the Ganges and Indus drainage, which were formerly narrow ocean straits. These straits were the recipients of the silt and alluvium washed out of the Himalayahs, and were at length elevated above the sea, so as to form the existing continent. The Sewalik Fauna then spread over the continent, from the mouth of the Irrawaddi to the Gulf of Cambay 2,000 miles, and north to the Jhelum 1,500 miles. After the long establishment of the Sewalik Fauna, a great upheavement took place along the line of the Himalayahs, elevating a narrow belt of the plains into the Selawik Hills, and adding many thousand feet to the height of the Himalayahs. The *red* stripe represents the Sewalik hills, stretching from the Hydaspes to the Gunduck River, 800 miles. The small *red* patch behind the Himalayahs represents the ossiferous plain of Tibet about 16,000 feet above the sea. The other *red* patches represent the Nerbudda and the Gulf of Cambay fossil tracts.'



Map illustrating Dr Falconers observations on the Geology of India

to illustrate that portion of the Sewalik hills extending from the Hysudrus or Sutlej, on to the Ganges, which has lately yielded an immense quantity of the fossil remains of a variety of new species of mammalia. This is the only part of the range which we have been able to examine, but for an exposition of its geological relations it will be necessary to notice the extent of the tract north-west and south-east of this portion.

Range and Extent.—The Sewalik hills appear to commence near the western bank of the Jhelum or Hydaspes, about E. long. 74°, and to run down to the eastward of the Gunduck in E. long. 85°, along an extent of at least 11°. It is probable that they are prolonged to the eastward in the Lohara Dunga range, till they are lost in the marine formations of Assam. From long. 74° to 82° the direction is about NW. and SE. To the eastward of 82° they bend so as to run almost due E. and W. Their axis is parallel to that of the great chain of the Himalayahs, and in the examined portion the strata have the same direction and dip. They are intersected along their whole line, at short intervals, by the numerous streams which unite to form the two great extra-montane river systems of drainage for the Himalayahs, that of the Indus to the west and of the Ganges to the east, the Brahmapootra being intra-montane along its entire course.

Extent of the known Tract.—The tract along which we have examined these hills from the Sutlej at Roopur, long. 76° 30′, to the Ganges at Hurdwar, 78° 10′, although considerable in itself, is small for the extent assigned to them; and some doubt might be entertained of the identity of the range along so protracted a line. But their physical and geographical characters are so marked, that a glance at the map would alone be convincing. Besides, from the hills at the eastern bank of the Sutlej, near Roopur, we have seen them stretching far off into the Punjab with the same north-westerly direction, and with a continuity interrupted only by the bed of the river; and in the same way they are seen from the heights at Hurdwar, running out of sight to the eastward as they skirt the hill province of Kumaon. Mr. McClelland[1] also gives a section and description of the Sub-Himalayan heights near the Gogra, long. 80° 20′, which show that Sewalik hills there are formed of the same beds, and attain similar heights as in the tract between the Jumna and Ganges. We are therefore certain of their geological identity along a line of 4° of longitude, or of about 272 miles. Captain Herbert[2] has also described them at the outlets of the Ramgunga and Cossillah rivers, as showing the same characters as at Hurdwar, and imagines the

[1] Geology of Kumaon.

[2] Herbert, Mineralogical Report, MSS. p 316.

same formation to extend from beyond Cashmeer to Patna, with valleys along the whole line.[1]

From our researches, we have been led to the opinion that the whole line of the Sewalik hills extending from the Indus nearly to the bay of Bengal, and formed by the débris of the Himalayahs, transported by the same causes acting under the same circumstances as at present, has been broken up from the plains of Hindostan and assumed its present Alpine characters within a very late geological epoch, posterior to the long establishment upon the north of India of animals so highly organised as the Quadrumana, of species of Camel, Ox, and Antelope, and of Crocodiles now existing in India. The importance and imposing character of the deductions demand a rigid investigation; and with the risk of being considered tedious and discursive, before entering on the Geological details of the formation, we shall prefix a sketch of the Physical characters of the neighbouring plains of Hindostan, and of the conterminous Himalayah chain.

The course of the Nerbudda, in lat. 23° to 24° N. naturally and geognostically divides the continent of India into two great portions: the southern or hilly, and the northern or 'plains of Hindostan.' The former is surrounded on all sides by distinct Alpine ranges, disposed pretty nearly in the form of a triangle; with the Great Vindhya range running E. & W. for its base, and the eastern and western Ghats for the sides. The two latter meet in the apex at the southern extremity of the continent near Cape Comorin, and at their northern limits they join on respectively with the eastern and western extremities of the Vindhya chain. From the western and central portion of the latter, subordinate ranges such as the Aravalli are sent off to the north, jutting into the division of the plains. The northern portion, or plains of Hindostan, is composed of the two great extra mountain basins of the river systems of the Himalayahs, the Ganges and Indus. These form two great alluvial plains. The one commencing in the delta of the Ganges and Megna stretches N W. from the Bay of Bengal in 22°, to the Guggar in lat. 31°, in one unbroken flat included between the Himalayahs on the NE. and the northern extremity of the eastern Ghat on the west, beyond which it expands to the west behind the Vindhya chain. The other commences in the delta of the Indus, and stretches north and east as marked by the five rivers of the Punjab, to the foot of the Himalayahs. The two basins are conterminous about halfway between the Jumna and Sutlej in lat. 30°, where they

[1] Herbert, p. 69, para. 57. Para. 284 and 285.

intermingle in one continuous flat, and with no hilly ridge intervening; and they stretch united across the continent through the plains of Hurrianah and the sandy desert beyond.

From the mouths of the Ganges up to the northern extremity of the Doab,[1] the Gangetic valley gradually rises, till at Suharunpoor it attains the height of 1,000 feet above the level of the sea, after a stretch of about 1,200 miles. The gulf of Scinde is about equi-distant from the same point, and the slope of the plains in that direction across the continent may be considered the same. In the north-western extension of the plains which form the basin of the Indus there appears to be no considerable elevation above the northern limit of the Gangetic valley, as without any mountain barrier to alter their direction the rivers converge to the west to flow into the Gulf of Cutch; and when they are conterminous, the Soamb, a branch of the Indus system, crosses the line of a canal, one branch of which runs towards the Indus and the other to the Bay of Bengal.

Himalayah Chain.—The Himalayah mountains bound the whole extent of this immense plain on its north-eastern side. This mighty chain, in all its features, is the grandest accumulation of mountain masses on the surface of the globe. Its lofty pinnacles, so long the subject of controversy, not only surpass all others in individual peaks, but maintain their overtowering elevation along lines of hundreds of miles. They are covered with vegetation where analogy would mantle them with snow. They embosom within their belt extensive plateaux or valleys abounding in numerous races, and covered with the works of man, as high as the loftiest peaks of Alps. Their rivers water the most fertile regions of the earth; their accumulated débris has formed a continent which supports a population equal to half of that of Europe. They separate two of the most densely peopled and distinct sections[2] of the human race, each of which claims for itself and the mountains above them a remoteness of antiquity reckoned only by millions of years; and so effectual a barrier do they oppose, that these races but a hundred miles apart are less known to each other than they are to the nations of Europe, divided from thence by thousands of miles of ocean.

Explored portion.—What of them is at all well known is but a limited tract included between the rivers Sutlej and Gogra, a line of about 270 miles; and here the scientific labours of Hodgson, Herbert, Webb, and the Gerards, have been so successful that the physical outlines of the mountains

[1] Mesopotamia of Hindostan.

[2] The Mongolian and Caucasian races.

have been as well laid down as any equal extent of Alpine tract in Europe.[1]

All westward from the Sutlej to the Indus is unexplored, and the same may be said of the tract from the Gogra to the Bay of Bengal.

One or other of us, Captain Cautley or myself, has had opportunities in repeated journeys of examining that portion of the mountains between the Ganges and the Sutlej. These journeys have extended as far as the sources of the Ganges and Jumna, and have intersected the lower tracts of mountain in various directions. As the chain possesses a great deal of uniformity of outline and physical characters generally, for nearly 1,000 miles, it may safely be presumed that the geognostical relations of the mountain masses, as exhibited in the tract we have examined, may be taken as a type of the whole; excepting the western prolongation along the valley of Cashmeer, where fossiliferous limestones are found. Further we have not had an opportunity of examining the fossiliferous limestones on the northern or Tartary slope.

As we attribute the formation of the whole line of the Sewalik hills to the alluvial degradation of the Himalayahs, we shall make no apology for entering at some length on their physical outline, river systems, and geological structure.

The Himalayah mountains are generally described as commencing in long. 75°, lat. 35°, where they join on with the Hindoo Koosh, and run down to Bootan, long. 90°, a course of 1,500 miles, skirting the plain of Hindostan. Their line of direction from the Indus is about from NW. to SE. South of the Gogra they get more easterly.

They form one of the mountain boundaries of an elevated

[1] We especially particularise the late Captain Herbert, who, besides an important share in the Trigonometrical labours of the Survey, investigated with great zeal the Geological and Mineralogical characters of the whole tract, and furnished a voluminous report to the Indian Government on the subject. Unfortunately, Captain Herbert was a self-taught and book geologist, and he was called upon to describe the geology of an unknown field—a subject new to him, at the very time when he was acquiring his first knowledge of geological science. The consequence is, that his labours have been less valuable than they otherwise would have been from his talents and general scientific acquirements with longer study. He has fallen into several important errors. He has described as gneiss an enormous protrusion of granite which forms the axis of the snowy range—shown in a colossal section across many miles, near the sources of the Ganges; and he has fallen into the same error with regard to a porphyritic trap, which forms a most important member of the Himalayan rocks. He has restricted the rock formations to granite and gneiss, and attached minor importance to an enormous formation of primary sandstone. We have been favoured lately with a perusal of his manuscript report *unpublished*, and in consequence, in writing on the same subject, we deem it necessary to notice the above, while our numerous references to his report tell how largely we have drawn from it.*

* Captain Herbert's Report was published as an appendix to vol. xi. of the Journal of the Asiatic Society.—[Ed.]

central tract from which all the great rivers of Asia radiate; on the Indian side their drainage being effected by the three great systems of the Indus, Ganges, and Brahmapootra. The most remarkable feature about the Himalayahs is a line of snowy peaks which may be considered as forming the axis of the chain, a plain supported on which, from Cashmeer to the Delta of the Ganges, would be elevated upwards of 20,000 feet above the level of the sea. Between this central range and the plains of Hindostan there is a belt of mountains of minor altitude, with an average elevation of about 7,000 or 8,000 feet. These intermingle with the Sewalik range, which rises abruptly from the plains.[1]

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The great chain of the Himalayahs rises in a ridge with an abrupt steep face against the plains of about 6,000 feet in height; there is then a slope from the crest of the ridge towards the north. This is the general character of the Himalayahs. The mountains on the side of the snowy range consist of a series of nearly parallel ridges, with intermediate valleys or hollows. They throw off spurs in all directions into the hollows, forming subordinate valleys. There is nothing like table-land (perhaps in the whole of the mountains, with the exception of Nepaul), and the valleys are rather broad, wedge-shaped chasms, contracted at the bottom to a mere water-course, than anything else; in fact, the ridges and intermediate valleys, as a general law, form a series of salient and re-entering angles, as seen in the sketch (fig. 1, p. 19). In consequence, the quantity of level or nearly level ground to be met with is most inconsiderable. From the dip or slope being towards the north, and the abutment to the south being steep, the great mass of vegetation has a northern exposure, and the southern faces of the mountains are generally naked.

The formations are primary; the first towards the plains consist of vast strata of limestone, lying on clay-slate, crowned by slate, greywacke, or sandstone. Beyond the limestone tract, gneiss, clay-slate, and other schistose rocks, occur. Granite, so far as I know, is not found in the outer ridges. It occurs in the mountains nearer the snowy range. I have not gone so far, and have not yet seen granite *in situ*. The igneous rocks, which have been concerned in the upheavement of the outer tracts, are of the green-stone trap series, and are very generally met with in dykes intersecting and rising through the regular strata. The formations

[1] The manuscript here breaks off abruptly. The three paragraphs which follow are extracted from an essay by Dr. Falconer, 'On the Aptitude of the Himalayan range for the Culture of the Tea plant' (Journal of the Asiatic Society, April, 1834).—[Ed.]

have a remarkable feature. The strata are in all directions fractured or comminuted; the slaty rocks are broken into small fragments, as if they had been crushed; and the limestone rocks are vesicular or cavernous, and broken up into masses.

The arrangement and nature of the soil take their character from the rocks. From the high angle at which the latter are inclined, and the northern direction of the slope, the soil is chiefly accumulated on the northern sides, where is also the vegetation. From the presence of schistose strata and limestone, the soil underlying the vegetable mould is clayey and calcareous, or limestone gravel. There is little sandy soil or sandy gravel. From the extreme richness of the vegetation, undisturbed for ages, and the moisture of the climate, there is usually a great accumulation on the northern slopes of vegetable mould; on the southern faces, the great steepness leaves little room for the accumulation of soil; where it occurs it is in patches, and consists of clays or limestone gravel, mixed up with vegetable mould. There is here also little sandy soil. Towards the crest of the slopes the soil is usually dry, from the moisture running speedily off; but lower down, and wherever the ground is tolerably level, the soil is quite damp, and perhaps it is rarely dry in the most parching seasons.[1]

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The Himalayah mountains are skirted on the SW. by a range of lower hills which separate them from the plains of India. These commence at Roopur on the Sutlej (see Plate III.), in sandy elevations of inconsiderable height, and run down a long way to the south, following the direction of the great chain. In some places they run up to the Himalayahs, and in others an intermediate valley lies between the two ranges, as that of the Dhoon. On their SW. side, which looks towards the plains, they are bounded by a broad belt of luxuriant Terai jungle. The following observations refer to that portion of the Sewalik hills which lies between the Jumna and Ganges. I have not had an opportunity of seeing them, where they extend to the east and west of the Ganges and Jumna respectively, but there is little doubt that the type of all that extends to the west of the Jumna, and of several hundred miles of the tract of hills to the east of the Ganges, is to be found in what lies between these two rivers.

The geological characters of the Sewalik hill formation possess great interest. They appear to consist of an upheaved portion of the plains of India lying at the foot of the Himalayah mountains. The nature of their mineral contents and depth of the strata give evidence of their having been formed

[1] What follows is another portion of MSS. on the same subject.—[Ed.]

during a comparatively recent geological æra, and of a vast series of ages having transpired during their deposition up to the period of their upheavement. Their coincidence with the great chain of the Himalayahs in parallelism, line of direction, similarity of dip, in contrast with the opposite nature of their rocks, connect them closely with the ingenious speculations of Elie de Beaumont, regarding the æras of upheavement of parallel mountain chains.

The Jumna-Gangetic portion has already attracted the attention of Indian geologists. The first published account of them, so far as I am aware, is by Lieut. Cautley, Superintendent of the Doab Canal, who in vol. xvi. of the 'Asiatic Researches,' has given a very accurate description of the mineral characters of the strata, in connection with the occurrence of coal and lignite, which first attracted his attention. It is to his zeal that we are indebted for the discovery of animal organic remains in the Sewalik hills. Captain Herbert, in the same volume of the 'Researches,' has described the tract from the Sutlej to the Kali rivers, and enters fully on the nature of the coal or lignite met with there. He seems to have formed the opinion that the formation is that of the rock marl or new red sandstone of England. Dr. Govan, in a paper on the Physical Geography of the Himalayahs, has given a brief sketch of the lower hills. He considers them as belonging to the oldest of Buckland's alluvial deposits.[1] The lower hills were examined by Mons. Jacquemont in 1831, but I am not aware that any account of them by him has been published.

The Himalayah mountains north of the valley of Deyra consist of primary stratified rocks, dipping towards the east of north; their abutment is to the south. Their line of direction is from NW. to SE. or thereabouts. The rocks consist chiefly of argillaceous schists and vast beds of limestone. The strata are inclined at a high angle. The mountains here at once rise with an abrupt mural front to about 7,000 ft. above the level of the sea, and 6,000 above the plains in the neighbourhood. No organic remains have as yet been met with in the outer ridges in the tract between the Sutlej and the Ganges, or on this side of the snowy range.[2] Of the unstratified rocks, greenstone traps, which were first, so far as I know, observed by Lt. Cautley, occur in considerable abund-

[1] Brewster's Journal of Science for 1825, vol. ii. p. 32.

[2] In my possession there is a small spiral-chambered univalve, closely resembling a Turritella, which I received from my friend Lt. Vicary, a most zealous and indefatigable traveller in the Himalayahs. Mr. Vicary met with it near Mussooree. The specimen was put by, without the fossil being observed till several days after. Mr. Vicary could not subsequently hit upon the spot where it was found, and as it might have been broken from a boulder, I have, pending the uncertainty about the matrix in which it occurred, attached no importance to the fossil till it should have been met with again *in situ*.

ance, rising in dykes through the stratified rocks, also diallage rock. I am not aware that granite is found in the outer ridges. It occurs abundantly in the Choor mountain. Its place in the outer ranges is occupied by the greenstone traps and diallage.

At the foot of the Himalayahs lies the valley of Deyra, stretching from the Jumna to the Ganges, and bounded on the south by the lower or Sewalik hills. It is situated about 1,400 ft. above the level of the sea. The plains in front of the Sewalik hills are about 1,000 feet above the sea, and stretch up to the foot of the hills with so slight an inclination as to be imperceptible to the eye. The hills rise abruptly from the plains. Their direction is from NW. to SE. parallel with the great chain of the Himalayahs. Their dip is mainly to the north-east. The strata are inclined at an angle of about 30° more or less, at different points. Within the British territories, they commence at Roopur on the Sutlej in inconsiderable heights. Stretching on towards the south they include the valley of Pinjore, and are here of but low elevation, and continue on to the Jumna but a few hundred feet in height. On the eastern bank of the Jumna they attain a greater height, till about half way on to the Ganges, where in the Kheeri pass they rise to an elevation of 2,000 ft. above the plains, or 3,000 above the sea. They fall off towards the Ganges, where their height is perhaps about 1,000 feet above the plains. On the east bank of the Ganges they are of nearly the same height, and run down a long way to the southward, skirting the flank of the Himalayahs.[1]

Between the Jumna and Ganges, the Sewalik hills are about 8 miles in breadth across their direction. They are intersected by numerous gorges or passes, connecting the plains with the Dhoon valley. The gorges where the Jumna and Ganges emerge into the plains are broad. The other passes which form the beds of torrents during the rains are wide at their mouths towards the plains, and gradually contract towards the Dhoon.

Approaching from the plains, the Sewalik hills are seen to rise with an abrupt, irregular, and deeply indented front. There are no round-backed hills. The crests are sharp ridges descending on the one side in a steep precipitous cliff, and on the other in a smooth and highly inclined slope. Ridge succeeds ridge in this manner, so as to form, across the line of direction, a series of close-packed serrated peaks, or a succession of pretty regular salient and re-entrant angles. So marked is this feature that in the approach one imagines he

[1] Captain Herbert, vol. xvi. Asiatic Researches.

is coming upon rocks of an older date and more durable structure. The strata may be divided into two classes: 1st, and lowermost, sandstone and conglomerate, containing subordinate beds of clay; 2nd, and uppermost, gravel.

The sandstone is a whitish grey arenaceous rock, varying a good deal in characters. It is generally of a whitish grey fine quartz basis, containing scales of white and some dark mica. It is incoherent and crumbles easily from pressure of the fingers. In some places the texture is so loose that it looks, where the surface of a cliff has been acted on by the weather, like well-packed sand. In others, although still loose in texture, it resists a sturdy blow from the hammer. The cementing basis is carbonate of lime, which is upon the whole abundant in the rocks. In the friable descriptions it is less so; the harder varieties effervesce strongly with acids. In some places the sandstone is extensively coloured by decomposed iron pyrites,[1] and this especially occurs where it contains lignite, as in the Kalowala pass. Where it comes in contact with the beds of clay, or the strata of conglomerate, the cementing basis is largely composed of argillaceous matter; and the rock possesses great hardness and tenacity. The sandstone, as above described, forms by far the greatest portion of the rocky mass of the lower hill strata. In some places fine sections are exhibited of great extent. About the middle of the Kheeri pass, a perpendicular cliff rises from the bed of the pass to a height of nearly 2,000 ft. It is of course inaccessible, except at the bottom; but so far as the eye can detect, it consists nearly uniformly of deep strata of whitish grey sandstone, without conglomerate or beds of clay.

The conglomerate consists of a clayey and arenaceous basis, in most instances highly impregnated with carbonate of lime, and cementing waterworn fragments of the older rocks of the Himalayahs. Captain Herbert has enumerated quartz, greywacke, granite, hornblende, and limestone: the fragments are usually of no great size. The strata vary in depth from a few inches to many feet, and alternate with the strata of sandstone. They are conformable, and regularly inclined with the sandstone strata.

The beds of clay are found in the sandstone and conglomerate, and modify the character of the rocks where they occur. The clay possesses different characters. In some places it is blue and tenacious, mixed up with sand; in others, yellow or light flesh-coloured, and greasy to the feel. It is generally lumpy and unequal, and rarely shows any appearance of foliation. The beds are of unequal depth, and rarely of any

[1] Cautley, *loc. cit.*

great extent. The depth, from a few inches to a foot and a half, thinning off and disappearing within a line of a few yards. It is very often accompanied by thin seams of coal or lignite, varying from a few lines to four inches—rarely more. The beds are very unequally distributed in the different portions of the range. In the Kheeri pass, clay is nearly absent, or seen only in very small quantities. In the Kalowala and Timli passes it is seen in more abundance. It is described as showing itself in a thick bed at Silani, by Lieut. Cautley.[1]

The sandstone and conglomerate occupy about three-fourths of the sections across the range, as exhibited in the different passes.

Lying uppermost, and in strata in every respect conformable with the sandstone, we meet with the deposits of gravel. The hills of which it is formed exhibit the same appearance as the other parts of the range. The same precipitous cliffs are seen towards the plains, and the same slope towards the Dhoon; but the strata never attain the height to which the sandstone reaches. Where the gravel is in contact with the uppermost bed of sandstone there is a gradual transition from the one rock to the other, or no very marked contrast in texture between them. The gravel here contains a great abundance of sand, the pebbles are small, seldom above an inch or two in size. The texture of the rock is very loose, and it crumbles under the fingers—lines of stratification are distinctly marked. Progressively as we get on towards the upper beds, the size of the pebbles increases, and the quantity of sand decreases, till in the uppermost beds, which are still clearly stratified, and inclined at the same angle as the rest of the range—about 30° to 35°, the gravel consists chiefly of large water-worn boulders, about half a foot or more in diameter. The deposit here has exactly the characters of the rolled boulders and gravel which form the bottom of the pass, which is itself in the rains the bed of a rapid stream, entirely dried up during the hot weather. The extent of the gravel is about two miles, and the cliffs in some places attain a height of 800 to 1,000 ft. above the beds of the passes.

Besides the beds of clay, the sandstone and conglomerate contain tabular masses of sandstone of a more compact texture, with the plain of gravitation parallel with that of stratification. The lower beds of gravel contain similar masses, but appearing to belong to the sandstone of the range. Nodules of clay are contained in the sandstone and conglo-

[1] Described as foliated or shaly at Silani. Cautley, *loc. cit.*

merate, and in some places the surface of exposed conglomerate is seen to be patched over with portions of a thin very crystalline carbonate of lime, simulating very much the appearance of portions of compressed marine bivalve shells, which I at first suspected them to be. They have a round, conchoidal surface, and a suitable thickness; but I have seen no specimen possessing unequivocal characters by which it could be referred to a shell.

Organic Remains.—The existence of coal or lignite in the Sewalik hills has been known since the Goorka war, and has led at different times to the idea that it might be found in sufficient quantities for mining speculation. Cautley and Herbert have described the circumstances under which it is found, and the latter has given a detailed account of its different varieties. The probability of any extensive coal or lignite deposit occurring in the formation will be afterwards considered. The carbonaceous matter is found in the sandstone and conglomerate, or in the beds of clay. I have specimens of it passing through every variety from a brown lignite, with the scarcely altered characters of a dicotyledonous wood, to a scarcely bituminised coal, of rich black with a high lustre and with no trace of woody structure. In its most perfect state it is but slightly bituminised, and it has more the characters of jet than of coal. It is found deposited in two ways; first, in thin wavy laminæ, from a few lines to a few inches deep, along the flexuous surface of the thin beds of clay. It is likely that here it was formed of vegetable matter left in small patches of limited lacustrine basins, such as the small *jhils* of Hindostan, or in the bed of a small sluggish stream. Secondly, in solitary masses, traversing the sandstone strata, and forming the ends of a log. It is often in such situations accompanied with a discoloration of the sandstone about it, owing to impregnation with iron from decomposed iron pyrites. It here has been formed of the imbedded trunk of a tree deposited in the sandstone. When of this description, it often retains a highly ligneous character. Of a number of specimens which I have examined from different localities, the lignite has always been of a dicotyledonous wood. I have seen no trace of any monocotyledonous woody remains. I have not been able to refer the woods to any class among the dicotyledones. No specimen has shown any of the characters of the wood of the Coniferæ, although the fibres were examined under a powerful microscope. One very perfect specimen in my possession, consisting of a large portion of the transverse diameter of the trunk of a large tree, has the bark converted into a substance nearly as hard and lustrous as jet; the woody

fibres are carbonised, and the interstices between them impregnated partly with siliceous matter, and partly with hydrated (carbonate of?) iron. No other vegetable remain has been seen, and so far as I know no portion of a leaf or other vegetable structure of any kind. In the Timli pass, I came upon a fine section of sandstone, in which from eight to ten feet are exposed longitudinally of the trunk of a large dicotyledonous tree, one foot nine inches in diameter, and upwards of five feet in circumference. The wood is silicified, part of the bark converted into lignite, and impregnated with crystals of sulphate of lime.

From the above description it will be seen that the Sewalik hills consist of a succession of beds, irregularly distributed, of sandstone, shingle, and conglomerate, surmounted by gravel. The section will give a general idea of the arrangement of the rocks; but it by no means professes to be exact in the details (see fig. 1).

Very opposite opinions have been advanced regarding the age of the Sewalik hill formation. Captain Herbert, from the occurrence of lignite and from the stretch of the range on to the Sutlej, was led to think that it was connected with the saliferous beds of Lahore, and might be identical with the new red sandstone of England. Captain Cautley advanced a similar opinion, more with the laudable object of having the matter agitated than determining it himself; but he has long since dropped it. Dr Govan designated the formation as belonging to the older alluvial deposits of Buckland. One can scarcely imagine more opposite geological conceptions of a formation. Mons. Jacquemont examined the lower hills in 1831, but I am not aware of any opinion he may have formed regarding them.

[The manuscript here ends abruptly, but the following passage is extracted from the Essay on Tea Cultivation above referred to, page 11.—Ed.]

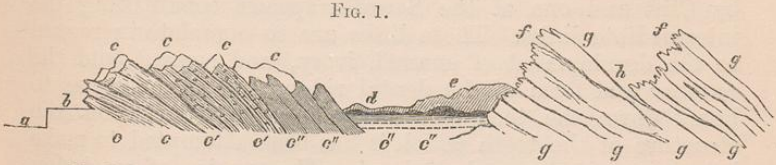
'I regard these hills as an upheaved portion of the plains at the foot of the Himalayahs, and that they are formed of the débris of the mountains washed down by streams and other natural causes. They are covered with vast forests of saul, toon, and fir, and are uninhabited.

'The soil of the Sewalik hills and of the valley of Deyra takes the character of the rocks. It is dry, sandy, or gravelly, with a considerable quantity of calcareous matter, and it appears to me to possess the character indicated for the tea districts in China.

'The Himalayahs have a direction running from NW. to SE. They consist, on this side of the snowy range, chiefly of primary rocks inclined at a considerable angle. The dip of

the strata is to the E. of N. and their abutment to the W. of S. On the flank of the great range there is a line of low hills, the Sewalik, which commences at Roopur on the Sutlej, and run down a long way to the south, skirting the great chain. In some places they run up to and rise upon the Himalayahs; in others, as in this neighbourhood (Suharunpoor), they are separated by an intermediate valley. Between the Jumna and Ganges they attain their greatest height, which Captain Herbert estimates at 2,000 feet above the plains at their foot; or 3,000 above the sea. Suharunpoor is about

FIG. 1.



a, Level of the sea at Calcutta; *b*, Level of Suharunpoor, 1,000 feet above the sea; *cc*, The Sewalik hills; *c'c'*, The strata of sandstone and conglomerate; *c''c''*, Strata of gravel; *dd*, The valley of Deyra; *ee*, Strata of the Sewalik hills, in some places rising on the Himalayahs; *ff*, Outer ridges of the Himalayahs; *gg*, Primary strata; *h*, The valleys or hollows between the ridges.

1,000 feet above the sea. About twenty-five miles north are the Sewalik hills. They are here about six or seven miles wide. To the east of the Ganges and west of the Jumna they gradually fall off. They have the same direction with the great chain, and agree generally in dip; their slope being towards the north, and abutment to the south. They rise at once against the plains, with an abrupt mural front. They are serrated across their direction, forming a succession of scarcely parallel ridges, with a steep face on one side, and slope on the other. The strata are inclined at an angle of 25° to 30°. They are of recent tertiary or alluvial formation, and consist of friable sandstone or gravelly conglomerate, agglutinated by a calcareous cement, containing subordinate beds of clay; the upper strata are entirely gravel. Beyond these hills lies the valley of Deyra, 1,200 or 1,400 feet above the sea, and then the great chain of the Himalayahs. The foregoing rude sketch will perhaps give an idea of the whole better than description; the distances are not in proportion in the section.'

C.

THE SEWALIK FAUNA—ITS EXTENT AND PECULIARITIES.[1]

The fossils were either collected at the foot of the cliffs, or blasted out of rock, or excavated. They were of two sorts, those formed in the sandstone being hard, while those in the

[1] This section is mainly constructed from letters written by Dr. Falconer.—[ED.]

clay were soft. The fossil Proboscidea are the most striking among the remains. The ordinary *Proboscidea* (*Dinotherium* being regarded as an aberrant form of the same family) may for convenience be divided into two genera, *Mastodon* and *Elephas*; although the Sewalik fossils show that these so-called genera are indistinguishable through any characters derived from the form and structure of the teeth. There is, indeed, a gradual and continuous passage in the structure of the teeth between the mastodon and elephant, the forms which have been included under the name of *Mastodon Elephantoïdes* by Clift and one of the Sewalik species constituting the intermediate links. These links are so complete in regard to the development of enamel, ivory, and cement, and the number and form of the dental ridges in the molars, as to break down the technical distinctions founded upon the structure of the teeth which it has been attempted to make between mastodon and elephant. The species of mastodon may be ranged under two sections, viz.:—

I. *Trilophodon*, or the mastodon having a ternary formula in the ridges of the intermediate molar teeth.

II. *Tetralophodon*, including the species with a quaternary formula.

Of *Trilophodon* there are no Indian species yet discovered, the group being at present limited to Europe and America, such as *M. giganteus*, *M. angustidens*, and *M. Tapiroides*. Of *Tetralophodon* there are three Indian species, viz. *M. Sivalensis*, *M. Perimensis*, and *M. latidens* (of Clift *ex parte*).

Elephas we divide into three sectional groups, viz.:—

I. *Stegodon*, being the species which Owen calls *Transitional mastodons*—the *M. Elephantoïdes* of Clift, and of which there are three, and perhaps four, Indian fossil species, viz. *Elephas Cliftii*, *E. insignis*, *E. bombifrons*, and *E. Ganesa*.

II. *Loxodon*, the species allied to the African elephant, of which we have but one Indian fossil species, viz. *E. planifrons*.

III. *Elasmodon*,[1] or the *thin-plated* Elephants (quoad molars), being the species allied to the mammoth and existing Indian elephant, of which two fossil species are found in India, viz. *E. Hysudricus*, a huge species with a concave forehead, and *E. Namadicus*, the species from the Nerbudda valley, with the remarkable bulge around the forehead. In all, ten fossil species of mastodon and elephant, as well as a new fossil species of *Dinotherium*, have been found in India. Six of these species have been found in the Sewalik hills. *Mastodon Perimensis* and *Dinotherium Indicum* come from

[1] Afterwards called *Euelephas* (See description of plates in Fauna Ant. Siv. Plates 42 to 44).—[Ed.]

Perim Island, *Mastodon latidens* and *Elephas Cliftii* from Ava, and *Elephas Namadicus* from the valley of the Nerbudda.[1] It follows, that in the Sewalik hills alone there were nearly as many fossil species of mastodon and elephant as there are now species of the whole order of *Pachydermata* upon the continent of India.[2]

Next come the *Hippopotami*, of which five fossil species have been found in India. One of these, *H. Palæindicus*, is a true hippopotamus with four incisors allied to the *H. major*, which we have included under the subgenus *Tetraprotodon*. Three, *H. Sivalensis*, *H. Iravaticus*, and *H. Namadicus*, differ from all species hitherto described in having the same number of incisors as the hog, viz. six in both jaws, and consequently we have constituted them into a new subgenus, *Hexaprotodon*. The fifth is so distinct, and in its teeth it so nearly approaches the ruminants as to form a new genus, *Merycopotamus*. The *Tetraprotodon* and *Hexaprotodon Namadicus* are from the valley of the Nerbudda; the *Hex. Iravaticus* from Ava; the *Hex. Sivalensis*, and *Merycopotamus dissimilis* from the Sewalik hills.[3]

Two fossil species of rhinoceros have been discovered in the Sewalik hills, *Rhinoceros Sivalensis* and *R. platyrhinus*; the cranium of the former being remarkably concave on its upper surface, that of the latter being flat. *Rhinoceros Sivalensis* was evidently unicorned, and it was also remarkable in having six instead of four incisors in both jaws. In this respect it resembled the contemporary hippopotamus of the same formations. A third species of fossil rhinoceros comes from Perim Island, *R. Perimensis*; and a fourth from the valley of the Nerbudda, *R. Namadicus*.

[1] For an account of the discovery of fossils in the valley of the Nerbudda, 'in consequence of a hint from Dr. Hugh Falconer,' see Journ. Asiat. Soc. October 1832, vol. i. p. 456.

Extract of letter to Sir Charles Lyell, 1855:—

'I have already made out two *perfectly distinct* Tertiary Faunas in India, the one in the Nerbudda (i.e. Central India), comparatively late, and characterised by *Elephas Namadicus*, *Hippopotamus palæindicus*, and a large species of *Bubalus*, with other *Bovidæ*, all of them perfectly different from those found in the Sewalik hills. The elephant is closely allied to the species I have named *Elephas antiquus* of Astiana in Piedmont, the Cromer (in part) and other fresh-water beds of Norfolk, and also of the caves in England and Fouvent in France. Strange it is that *Elephas Namadicus* is nearer to the English species than to the existing Indian species, although in time only a little ahead of the latter. This is a fact for Darwin.

'The hippopotamus of the Nerbudda is like the existing African and Val d'Arno fossil species, a *Tetraprotodon*, while the Sewalik and Ava species are *Hexaprotodons*. We have never yet found *Mastodon* in the Nerbudda Fauna; but we have got sparing remains of one of the Sewalik *Stegodons*, i. e. intermediate elephants, from it.

'The large ruminants of the Sewalik Fauna are none of them of the modern types of *Bovidæ*.'—[Ed.]

[2] The above account is derived from a letter to Mr. Broderip, dated April 6, 1845.—[Ed].

[3] Mainly from a letter to M. de Blainville in 1846.—[Ed.]

The Sewalik fossils include three species of *Suidæ: Sus Hysudricus*, *Sus giganteus*, and a new genus, *Hippohyus Sivalensis*, with teeth exhibiting a strong tendency towards the hippopotamus;[1] also the *Chalicotherium Sivalense*, one of the most remarkably aberrant pachyderms that have yet been met with, either in the fossil or recent state, closely allied to *Anoplotherium*, but showing a return from the ruminant tendencies of the Cuvierian species back to a more pachydermatous type, and a closer affinity with rhinoceros.

The family of *Equidae* was represented by three Sewalik species, *Equus Sivalensis*, *Equus Palæonus*,[2] and *Hippotherium Antelopinum*, the last exhibiting the characters of a small horse, drawn out into the attenuated proportions of an antelope. The remains of a third species has been found in the Netee Pars, and another fossil species, *Equus Namadicus*, has been obtained from the valley of the Nerbudda.

The fossil ruminants of the Sewaliks are surprisingly rich, and include almost every type, fossil or recent, known in the order. In the first place, there are two species of giraffe, *Camelopardalis Sivalensis* and *C. affinis*, and a species of camel, *Camelus Sivalensis*, neither of which genera have before been found in the fossil state. Then there is the new genus, the gigantic *Sivatherium*, bearing four horns, nearly approaching the elephant in size, and considerably exceeding the rhinoceros. Among its chief peculiarities are the immense width of cranium for muscular attachments, the fore and hind horns, the arched form of the nasal bones, as in Tapir; the massiveness, width, and shortness of the face, and the curving upwards of the grinding plane of the teeth, as in Darwin's American ox. As to its affinities, the teeth are those of a giraffe; in its four horns, it resembles the *Antilope quadricornis*, while the near horns resemble those of a dicranocerine antelope from North America. In the head, the nearest affinities are to the ox, in regard to the plane of the frontal and occipital, the parietals being joined on to the occipital. The upper lip was prolonged into a trunk. The front horns were remarkable for their flat form, and in the absence of a bur, notwithstanding the guttering. The neck vertebræ are short, and the legs of huge dimensions. Altogether, the *Sivatherium* was a remarkable form of animal, unlike anything living. Closely

[1] As no description of these fossil *Suidæ* was ever published, the reader is referred to the description of the plates in the Fauna Antiqua Sivalensis (lxix. to lxxi.), and also to a memoir by Messrs. Baker and Durand in the Journal of the Asiatic Society for October, 1836. Vol. v. p. 661; also vol. iv. p. 568.—[Ed.]

[2] M. Lartet, in a letter to Dr. Falconer, dated August 1855, was inclined to regard *Equus Palæonus* as a young individual of either *E. Sivalensis* or *E. Namadicus*.—[Ed.]

allied to it is another new genus, the *Brahmatherium*, from Perim Island. Among the *Cervidæ* are two species of Sewalik *Cervus*, and the *Dorcatherium moschinum*; two other species of fossil cervus, *Cervus Namadicus*, and *Cervus Palæindicus*, have been obtained from the valley of the Nerbudda. The Sewalik fossils also include at least two species of antelope, *Antelope Palæindicus*, and *A. gyricornis*; and numerous species of *Bovidæ*, viz. *Bison Sivalensis*, *Bos occipitalis*, *Amphibos acuticornis*, *Amphibos elatus*, *Amphibos antelopinus*, *Hemibos triquitriceras*; two additional species, *Bos palæindicus*, and *Bos Namadicus*,[1] have been found in the valley of the Nerbudda.

The Sewalik *Carnivora* comprehend fossil species of *Felis*, *Hyæna*, *Canis*, *Fox*, *Mustelidæ*, *Machairodus*, and the new forms of *Hyænarctos* and *Enhydriodon*, or fossil otter.

The *Quadrumana* are represented by four fossil species, and there are also several forms of *Rodentia* and *Insectivora*, including *Hystrix*, *Mus*,[2] and a new undescribed genus, *Typhlodon*.

The Sewalik *Reptilia* are exceedingly rich in forms, particularly of the Crocodiles and Chelonians (*Emys*, *Trionyx* and *Testudo*), some of which, such as *Leptorhynchus Gangeticus* and *Emys tectum*, are indistinguishable from existing species; while the *Colossochelys Atlas* is a prodigy of size in the order. It is in every part of its organisation a true land tortoise, estimated from numerous remains to have had a shell twelve feet long and six feet high. The possible connection of this fossil with the fossil which figures so prominently in the Pythagorean and Hindu cosmogonies is a subject of interesting speculation.

Among the Sewalik fossils there are also the remains of several species of *Birds*, including *Grallae*, greatly surpassing in size the gigantic crane of Bengal (*Ciconia Argala*); and of *Fishes*, *Crustacea*, and *Mollusca*.

* * * * * *

At the previous meeting,[3] when I had the honour of addressing you, I had to wade through such a number of facts, in explaining, although in the briefest way, the various animals which entered into the Sewalik fauna, that the time to which I was limited was more than over before I was done with them. I had, in consequence, to terminate abruptly, before I could indicate to what general consequences the mass of facts tended. For you are not to suppose that the subject is

[1] Few of these species have as yet been described, but the specimens named by Dr. Falconer are in the British Museum.—[Ed.]

[2] Journ. Asiatic Soc. December 1835. Vol. iv. p. 706, and vol. v. p. 296.

[3] See note, p. 1.—[Ed.]

one merely of curious interest, resting on the numerous animals and remarkable forms with which we are occupied. It involves important considerations regarding the former condition of India, in respect of climate, geographical character, and the alterations of surface which it has undergone in the upheavement of the Himalayahs and of the Sewalik hills. To these points I shall now direct your attention; but in order to bring the subject clearly before you, it will be necessary in the first instance to review some of the leading features of the Sewalik fauna.

The first character which strikes us is the wonderful richness and exuberant variety of forms. In the Pachydermata, which are now restricted in continental India to four genera and four or five species, there were then *twice* the number of genera, *and about five times the number of species.* Of the Proboscidean Pachydermata alone, including the elephant and mastodon, there were as many Sewalik species as are now comprised in the whole order in India, and the same holds good as to the Ruminantia. Besides a large number of species representing those which now inhabit the continent, such as the ox, buffalo, bison, deer, antelope, musk-deer, and others, there were more than one species of giraffe and of camel, together with the Sivatherium—in fact, representatives of every type known in the order, fossil or recent, either in India or elsewhere. And so on through the Carnivora, which were singularly rich and varied in forms, and through the Quadrumana, Rodentia, Insectivora—Birds, Reptiles, Fish, Crustacea, and Mollusca. Nor is there the slightest proof that this mass of species were not alive at the same time, but interpolated Successively at different periods. The remains of all were found reposing together, in the same beds of the same strata.

The next striking feature is the close analogy between the existing fauna of India, so far as it goes, and the extinct fauna. What we have at present is but a reduced, or as it were remnant, representation of what existed before. India has no marsupial animals now; and up to the present time no remains referable to that class have been detected among the Sewalik fossils. The same holds in regard to the Edentata. India contains at present but a single species, the *Manis crassicaudata*; and we have not found one in the fossil state, although at least one may yet be expected. In like manner, the cetacea which are represented by the solitary *Platanista Gangetica*, or dolphin of the Ganges, have as yet yielded no fossil representative, although, as in the case of the manis, one or more may be expected. It is interesting to keep this fact of parallel representation in mind, as the same law has

been found to hold generally good in two other remarkable instances, Australia and America. The former country is at present the head-quarters of the marsupial tribes, and the same is the leading character of what is known of its fossil fauna. In like manner America, which is now the great home of the Edentata, has yielded almost all the gigantic forms of that order known to us—such as the Megatherium and others. But in marking the general analogy which runs between the ancient and the existing fauna of India, we are struck, considering the number of forms which have become extinct, with the extreme reduction of species. Not only have the Proboscidean pachyderms declined from five to one, and the Equidæ from three to one, but numerous genera have died off entirely: we have nothing remaining of the Hexaprotodon Hippopotami, the Merycopotamus, Anoplotherium, Hippohyus, Enhydriodon, Hyænarctos, Sivatherium, Camel, Giraffe, and other forms which I could enumerate. The conclusion is irresistible, that the æra of the great force and development of the vertebrated animals in India has gone by, and that what we now see as our contemporaries are, as it were, but a ragged remnant representation of the rich garment of life with which the continent was formerly clothed.

The next remarkable character is the singular mixture of representatives of old and new, past and existing forms, which are grouped together in the Sewalik fauna. I allude especially to the *Anoplotherium Sivalense*, the bones of which were discovered crossed in the same clay matrix with those of camel, antelope, and giraffe. The species comes nearest to that which has been described by Kaup as the *Chalicotherium Goldfussi*, from the miocene beds of Eppelsheim, the generic distinction having been founded apparently from mistaking the false molars for incisors.[1] But the great development of the genus is in the Eocene tertiaries of Europe; while in the Sewalik hills the species is associated with several quadrumana closely allied to existing forms, and even with fossil reptilia, now known to us as existing species. In addition to the Anoplotherium, excellent observers like Messrs. Baker and Durand, and Dr. McClelland, have mentioned the Palæotherium as a Sewalik fossil; but no remains referable to that genus have yet come under our observation. Some of the other Sewalik animals, such as the Machairodus or *Ursus cultridens*, and the Merycopotamus, which is closely allied to the Anthracotherium, indicate a similar tendency towards the faunas of the older tertiaries of Europe, in a portion of the Sewalik fauna. At the present day we only know the giraffe

[1] Dr. F. afterwards regarded *Anoplotherium Sivalense* as belonging to Kaup's genus, *Chalicotherium*.—[Ed.]

and the hippopotamus as strictly confined to the African continent. But the head-quarters and force of these genera appear to have been formerly in India. In short, it would seem as if all the geographical divisions of the old continent, and all the epochs, from the Eocene downwards, had contributed their representatives to constitute one vast and comprehensive fauna in ancient India.

The next striking point is the peculiarity of type and number of transitionary forms which run as a general feature through the Sewalik fauna. The mastodons and elephants pass into each other through intermediate species. The hippopotami have the full complement of incisive teeth, and the same is indicated in regard to forms allied to rhinoceros. The *Hyænarctos* is the most abnormal in its dentition of any known ursine form. The *Enhydriodon* was a Lutrine animal, the size of a panther: while the *Colossochelys* tortoise was a prodigy of size in its order.

In regard to the nature of the species, in so far as the evidence has yet been worked out among the mammifers, all the ascertained species have turned out to be extinct, and in almost every instance different from those known elsewhere in the fossil state. But I put forward this statement with the reservation that the evidence has not in every case been complete enough to be decisive, and that in several instances the fossil forms make the closest approach to species now living in India. This is the case with several of the carnivora; while the teeth of one of the species of giraffe comes so near those of the existing African species in size and form as to be indistinguishable. The Sewalik reptilia, on the other hand, exhibit a mixture of recent and extinct species. The same appears to be the case with the fish; but in this order the evidence has not yet been gone into sufficiently to justify pronouncing with any confidence. In regard to the mollusca, which are regarded as the main evidence for determining the age of geological formations, the species belong to land and freshwater genera now common in India. Mr. Benson, our best authority on Indian shells, considered the most, if not the whole, of them as identical with existing species. They are now in the hands of my distinguished friend Professor Forbes, by whom they will soon be carefully worked out. I am permitted to say that he has already been able to identify some of the species with existing forms.

Nothing approaching human remains or industrial monuments has ever been met with among the Sewalik fossils collected along a line of 360 miles, thus confirming what the evidence derived from all sources goes to show, the late origin and very modern advent of man into the system. Yet when

we found the remains of such forms as the camel, giraffe, and quadrumana with existing reptilia pouring in upon us, each successive ascertained form appeared to indicate a nearer and nearer approach to the human period; and when we had exhausted the list, the question used to arise, what shall we find next?—but man and his works were to the last wanting. The Sewalik fauna was not merely surprisingly rich in species, but equally so in the vast number of individuals which the plains of ancient India subsisted. The collection of fossil bones which Captain Cautley presented to the British Museum amounted to 200 chests, averaging about a hundred-weight each of contents. Another collection formed by myself was nearly as extensive. Captains Baker and Durand, in April 1836, at an early stage of their collection, took the trouble of tabulating the number of heads and jaws with teeth contained among their fossils; and the following are extracted from their list.

ELEPHANT AND MASTODON.	Fragments of upper jaws and heads.	Lower jaws.	Mutilated fragments of jaws.
	110	101	56
HIPPOPOTAMUS.	Crania and upper jaws.	Lower jaws.	
	46	63	
PACHYDERMATA GENERALLY.	Upper jaws.		
	222	225	
RUMINANTS.	143	230	

Now when it is remembered that the aggregate collections have been more than tenfold increased since, and that the remains were either excavated or found in débris of cliffs, and that the explored surface bears a very small proportion to that which has not yet been investigated, one may form an estimate of the prodigious number of animals which must have lived together in the former plains of India, making every allowance for the bones having accumulated during many successive generations.

Viewed as a whole, what designation are we to assign to the Sewalik fauna? The shell evidence is still to be worked out; but it has already been shown either that the majority are identical with existing forms, or that there is a mixture of recent species with a series of extinct forms closely representing existing ones. The evidence from the vertebrate animals is of a double character; half of them are so like the fauna which we now have in India, that they might pass for the creatures of yesterday, while the other half represents the

characters of the middle and older tertiaries of Europe. That they belong to the vertebrate series which immediately preceded the existing race of animals is hardly susceptible of doubt from the admixture of existing reptiles.[1] * * * And as changes of the fossil fauna of Europe, which mark the different subdivisions of the tertiary series, have been shown to have been coincident with changes of climate, and repeated elevations and depressions of temperature—if we can only show that the climate of India has been less subject to great oscillations during the tertiary period, and that the surface of the land enjoyed longer periods of repose, it would be, perhaps, not unphilosophical to conceive that the epoch of the Sewalik fauna may have lasted through a period corresponding to more than one of the tertiary periods of Europe.

D.

GEOLOGICAL AND CLIMATAL BEARINGS OF THE SEWALIK FAUNA.

Besides the mere zoological interest of the subject, the Sewalik inquiries involve these conclusions.

1. The upheavement of a narrow belt of the plains of India at the foot of the Himalayahs into hills 3,500 ft. high along 11° of longitude, or about 800 miles, after the long establishment on the continent of such modern forms as quadrumana, camel, giraffe, and existing species of reptilia.

2. A great upheavement of the Himalayahs, extending to many thousand feet, and equal to the elevation of a tract which formerly bore a tropical fauna, up to a height which now causes a climate of nearly arctic severity. Remains of rhinoceros, antelope, hyæna, horse, large ruminants, &c., found at 16,000 feet above the sea.[2]

3. Conditions in India during the tertiary period precisely the reverse of what have held in Europe. Instead of a succession of periods with successive decrease of temperature, India has now as high a temperature, if not higher, than it ever had during the tertiary period. The upheavements have operated to increase the heat. In lat. 30°, at 7,000 feet above the sea, the mean temperature, making the compensation for the elevation, and reducing it to the level of the sea, is 81·2° Fahr., or equal to that of the equator. The same excess of temperature holds generally over the continent, as contrasted with the eastern side of the continent of Asia.

4. Instead of numerous subdivisions of the tertiary period with successive faunas, facts tend to the conclusion that India had one long term, and one protracted fauna, which lived

[1] Manuscript defective.—[Ed.]

[2] On this matter, see further the memoir on The Fossil Rhinoceros of Tibet.—[Ed].

through a period corresponding to several terms of the tertiary period in Europe.

The continent of India, at an early period of the tertiary epoch, appears to have been a large island, situated in a bight formed by the Himalayahs and Hindoo Koosh ranges. The valleys of the Ganges and Indus formed a long estuary, into which the drainage of the Himalayahs poured its silt and alluvium. An upheavement took place, which converted these straits into the plains of India, connecting them with the ancient island, and forming the existing continent. The Sewalik fauna then spread over the continent from the Irrawaddi to the mouths of the Indus, two thousand miles; and northwest to the Jhelum, fifteen hundred miles. After a long interval of repose, another great upheavement followed, which threw up a strip of the plains of India, forming the Sewalik hills, and increased the elevation of the Himalayahs by many thousand feet. This event, and the climatal changes which it involved, caused the extinction of the Tibetian and Sewalik faunas. As a result of the climatal changes implicated in these upheavements, it may be inferred that India is now enjoying 'the summer of the great cycle;' and that, in contrast with what has taken place in Europe, there has been no decrease of temperature in that country, which has now as warm a climate, if not warmer, than it ever had during any part of the tertiary period. (See Plate II.)