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INAUGURAL ADDRESS

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THE

BORDER LANDS OF GEOLOGY AND HISTORY.

THE last ten years have been marked by a very considerable extension of our knowledge of China and the immediately adjoining countries: and I propose on the present occasion to pass in review some additional sources of information, more especially those which seem to throw light on the past history of the earth; and to affect more or less intimately certain theories on the later stages of geological time which have found favour in Europe and elsewhere.

In Europe the period has been one of decided change in men's ideas. Ten years ago the contest with regard to development was still at its height. It may now be considered as closed so far as the acceptance of gradual development as a necessity of living organisms is concerned, though it still rages on details and immediate causes, where much debateable land still remains for future conquest.

On other subjects opinions are, however, more than ever upset, and on no subject more than on the history of our globe in the ages immediately antecedent to the advent of the present races of men; accompanied as the monuments of that period are in Europe and America, at least, by traces of a climate many degrees colder than that at present prevailing in the same latitudes.

Two causes have recently concurred in causing more than usual attention to be devoted to such subjects; and have tended to a considerable degree to shake confidence in theories which a few years ago bid fair to meet with general acceptance.

which themselves rest on the Nanking gravels and sandstones apparently of tertiary age. All trace of volcanic action has not yet ceased in this district; warm springs are numerous, and Nanking is still the centre of a small earthquake district extending from Shanghai to Kiukiang, and from the Yellow River to a little south of Ningpo.

The Loess is immediately succeeded by the alluvial plain of the Yangtsze and Yellow River, the fluvial deposits of which are as free from any traces of glacial action as the Loess itself. I have from calculations of the out-flow of the Yangtsze put down 13,500 years as the probable time of accumulation of the delta, the formation of which must have commenced immediately on the first emergence of the Loess above water. If we double the period we still must consider it late in geologic, if not in human time. This would require the surface of the Yangtsze basin to have been denuded at the average rate of about one foot in 2,700 years; by no means an excessive rate when the large portion of its area occupied by light loamy deposits is considered, as well as the great annual floods to which it is subject; the difference between summer and winter level at Hankow amounting to from 40 to 53 feet.

So far I have confined myself to the geological evidence against the occurrence of a glacial epoch in northern Asia, and I have shown that these proofs extended to latitudes far north of those where abundant proofs of former glaciation are forthcoming in Europe and North America. So convincing have those proofs seemed that Mr. Geikie (*l. c.*) cannot help yielding to the evidence that in northern Asia we have to look to a time of increasing cold, rather than to an ameliorated climate. Turning from geology to zoology we shall find what seem convincing proofs of the modern refrigeration of northern Siberia, and eastern Asia generally, in the comparison between its present and its recently extinct fauna; as well as in the geographical distribution of those animals that survive.

It has been an acknowledged difficulty in the present state of our information to account for the disappearance of the rhinoceros and elephant, the remains of which are found in abundance all over northern Siberia. It it probably owing rather to the indirect than the direct effect of changes of climate; yet there are localities in Siberia, as in the upper valley of the Yenesei where such food as the rhinoceros tichorinus is known to have consumed is still abundant. The portion of the earth which at present supports a fauna bearing the greatest resemblance to that which formerly inhabited Siberia is undoubtedly the plains of southern Africa. Here the country is dry and

sterile, almost approaching a desert, thinly covered with grass and low bushes, and apparently providing but little fodder for herbivorous animals. Yet no where else do the larger mammalia abound in such numbers.* The probable reason is the uniformity of the seasons, and the absence of snow and ice in winter, which would demand a specialisation on the part of the mammals such as we find in the reindeer of the arctic regions.

The tichorhine rhinoceros and the mammoth seem, however, to have been more or less adapted to stand the rigours of a cold climate. Their history in Europe is a curious one. They first appear in company with other species, R. hemitœchus and megarhinus and elephas antiquus, apparently inhabitants of the warmer parts of the temperate zone. Along with these are met with types now so widely separated as the musk sheep of the arctic regions and the hippopotamus, the latter only surviving in Africa.

The approach of the glacial period in Europe forced the other elephants and rhinoceroses either to die out or remove to Africa; while the mammoth and tichorhine rhinoceros became more or less modified to suit the colder climate prevailing, the extreme of such modification being seen in the reindeer and the musk sheep. On the return of a warmer climate the depression of the Mediterranean cut off the return of the old forms from Africa, while by the rising of the valley of the Obi and Irtish a road into now congenial climates was afforded to the others, who made their quarters for a time in Siberia. Southern Asia was apparently at this time still cut off from the north of the continent by the Loess sea, which prevented a mixing of northern and southern forms: and the remains of this position of affairs are still seen in the distinction between the Indo-Chinese fauna of south China and the Palæarctic of the districts north of the Yangtsze.

The geological formation in which the remains of these extinct animals are found seems to point to altered conditions of climate. It is composed of thick beds of sand and clay interpersed with layers of fossil wood or lignite, the latter in some cases turned into black coal. These beds usually contain marine fossils, proving that at the time land did not extend so far north as at present. The thickness of the beds probably points to a moister climate on the adjacent land than prevails at present, when floods were more frequent in the rivers; and this was doubtless due to the large Loess sea lying immediately to the south. A moist temperate climate with mild winter and

* See "Voyage of a Naturalist," p. 86 *et seq.*, ed. 1873.

cool summers probably prevailed; willow and pine woods flourished, and the elephant and rhinoceros had abundant food during the whole of the year; and, what was perhaps of greater importance, a sufficiency of water even in mid-winter.

With the elevation of Central Asia and the extinction of the Loess sea the supply of moisture from the south sea was cut off; the elevation of the old coast line, which caused the appearance above water of the barren tundras of the north, aided in the change, and a probable movement of the pole along the meridian of 90° brought at the same time northern Siberia within the arctic regions. Some individuals doubtless lived on in spite of the cold, and their remains curiously preserved in ice add another proof that a diminution of temperature has occurred; and afford us the means of determining with certitude the external appearance of these old giants. The times, however, at last became too hard for elephant and rhinoceros, and they were forced to commence a retreat towards the south.

The rising plateau of Pamîr was perhaps too sterile, but to the east lay the plains of north China and Mongolia recently emerged from the Loess sea, and covered to a greater extent than now with forest, and into these districts the old mammals made their way. The rhinoceros and elephant certainly lived in Honan B.C. 600. The Tso-chuen commenting on the C'hun-t'siu of the 2nd year of the duke Siuen (B.C. 605) describes the former as being in sufficient abundance to supply skins for armour. The want, according to the popular saying, was not of rhinoceroses to supply skins, but of courage to animate the wearers. From the same authority, (duke Hi XIII. B.C. 636) we learn that while T'soo (Hukwang) produced ivory and rhinoceros skins in abundance, Tsin, lying north of the Yellow river on the most elevated part of the Loess, was dependent on the other for its supplies of those commodities. The "Tribute of Yu" tells the same tale. Yangchow and King (Kiangpeh and Hukwang) we are told sent tribute of ivory and rhinoceros hide, while Liang (Shensi) sent the skins of foxes and bears. Going back to mythical times we find Mencius (III. II. 9.) telling how Chow kung expelled from Lu (Shantung) the elephants and rhinoceroses, the tigers and leopards; proving that in more northern regions the tradition of their former existence was handed down to a few centuries before our era. It is of course impossible absolutely to tell to what species the elephant and rhinoceros of the old Chinese writers are to be referred, but the Abbé David describes his finding remains of E. primigenius and R. tichorhinus in superficial deposits in the Loess on the

borders of Mongolia,* associated with several species of deer, with the horse, oxen, &c. Sub fossil teeth of both these species are commonly to be found in the medicine shops, and one of the localities given for their occurrence is north China and Mongolia. Altogether although the superficial deposits of Szechuen supply a rich mammalian fauna in great measure identical with that of the miocene deposits of the Siwalik hills, and amongst which are to be found remains of R. palæindicus, mastodon sivalensis, elephas planifrons? and numerous other palæ-Indian forms, the balance of evidence seems to be in favour of the mammoth and tichorhinus. The occurrence of the older forms in Szechuen, which formed the extreme limit of the old Indo-Chinese continent in miocene times is easily explained, but it seems unlikely that they should have survived to so late a date. It will be more consonant with what we know besides of the movements of animals immediately before the present age, to believe that the descendants of the old miocene animals for the most part travelled south, when the Siberian mammals invaded China on the north. The elephants and rhinoceroses chased from Shantung by Chow kung, and which still, B.C. 600 survived in Honan may well have been the last remains of those which had previously emigrated from Europe to Siberia; and thence on the approach of arctic cold and the general desiccation of northern Asia travelled on to the raised land of north China.

Even here the same causes were probably at work which had rendered Siberia uninhabitable. The raised plains of Shensi and Shansi were too dry, and their winter climate too severe for the old animals; they were besides in early times settled by a race of men peculiarly agricultural. Adjacent lay the moister plains of Honan and Hukwang where food and water could be procured all the year round, and which moreover were later in accepting Chinese civilisation; and here the elephant and rhinoceros survived till exterminated by man within historical times.

This view will account likewise for what we know of the history of another remarkable form, the *cervus* (elaphurus) *davidianus*, or tailed deer of the Abbé David. Of all the cervidæ it approaches nearest the reindeer in the structure of its hoofs, and the large callosities behind, which fit it for a life amidst marshes. It was probably its similar peculiarity, as well as the shape of its horns, which permitted the reindeer to remain an inhabitant of the snowy plains of Europe when invaded by the increasing cold of the coming glacial epoch. Less

* Journal de mon Troisème Voyage, p. 93.