LADAKH, WITH SPECIAL REFERENCE TO ITS NATURAL HISTORY

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IN February 1925 I decided to satisfy one of my long-cherished desires —to visit Ladakh. The object in view was to see the country from a zoological aspect whilst making an intensive study of the conditions under which life exists in high altitudes. It was essential for my purpose that Leh should be reached in early spring: there was therefore little time to waste in making preparations.

This paper has been divided into two parts. The first deals with the route and certain matters of interest encountered on the way, for without a clear conception of the character of the country Part II. of this paper would lose a deal of its value. Part II. deals with a contribution towards our knowledge of the origin of life in the Himalayas and on the Tibetan Plateau.

Part I. Our Route in Ladakh

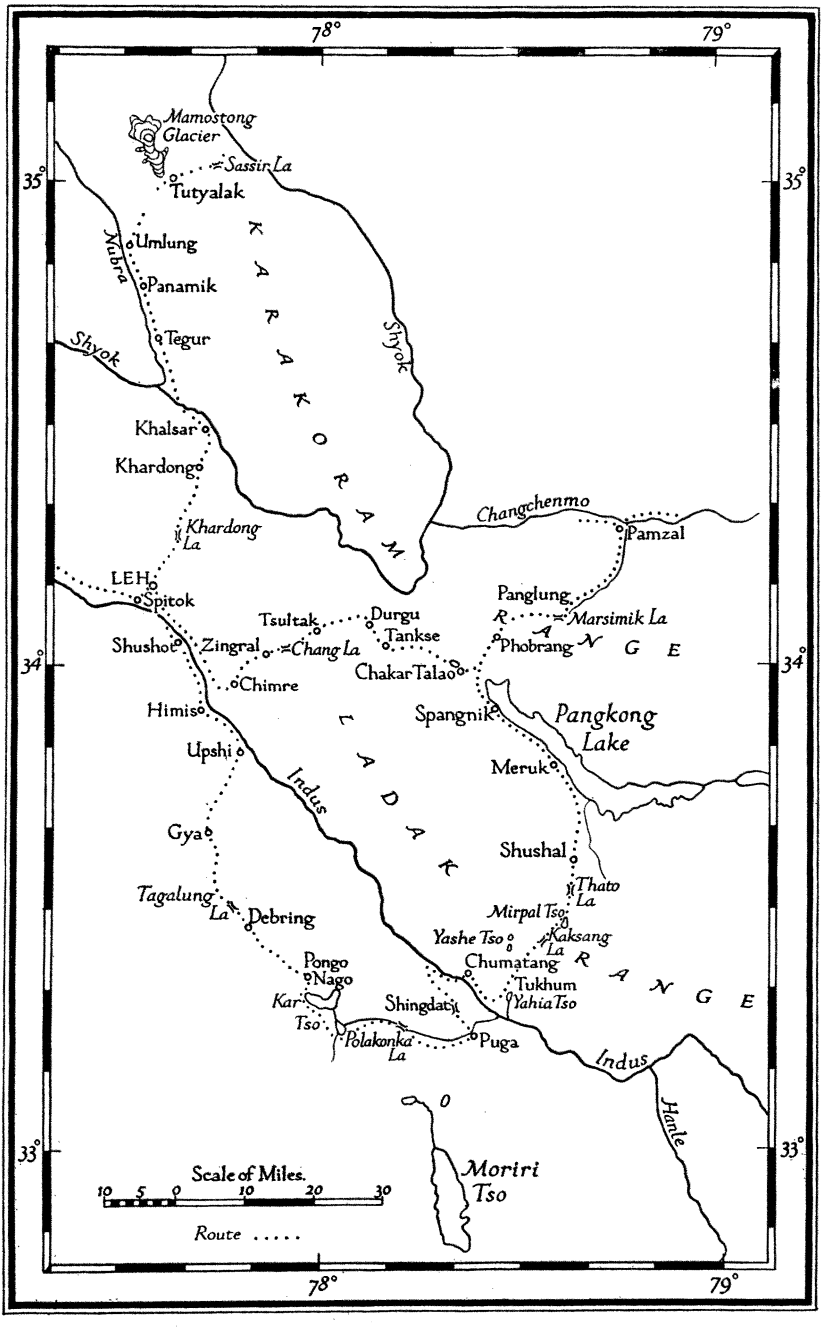
Passing up the Treaty Road we reached Leh on May 4. There is an interesting fact about Leh which appears to have escaped notice. The first European traveller to visit Leh was, I believe, Francesco de Azevedo on 25 October 1631. He writes, "It is built on the slope of a small mountain and numbers about 800 families. Half a mile lower down, but still quite visible, flows the river which goes to Lahore. By the town itself passes a mountain stream, which works a large number of mills; a few trees are found here."

This description does not fit modern Leh, which stands 6 miles from the right bank of the Indus. The old site of Leh is probably near Spitok, which abounds in *débris* of what might quite well have been the old town. The river Indus cannot have altered its bed, because modern Leh stands on an alluvial fan 500 feet above the Indus.

Leh is entered through an archway which leads directly into the main bazaar, the business centre of the Ladakhi capital. Everything centres round this bazaar, the monasteries and old palace of the Kings of Ladakh being perched on a serrated ridge above and to the north-east of the town.

My idea was now to proceed east to the Changchenmo, and then south down the Pangkong Lake, cross the Indus into Rupshu, and then return to Leh in time for a trip to the Karakoram.

Leaving Leh on May 17, we passed up the right bank of the Indus for a short distance, then striking left-handed up a tributary valley, we camped at the foot of the Chang La. At the neighbouring village of Chimre we were fortunate in meeting the Abbot of Himis, the spiritual head of Lamaism in Ladakh. He goes by the name of Guru Stagtsang



Sketch-map showing Colonel Meinertzhagen's route through Ladakh

Raspa, and is an intelligent, nicely mannered old gentleman. We called on His Holiness, who received us in a small heavily scented room on the top floor of the monastery. For the first half-hour we were bombarded with questions. His knowledge of geography was crude. London and Peking were both quite close to each other and three days by steamer from Bombay. He had many possessions, including a small camera, an electric torch, a bottle of Pascall's sweets, and a fine assortment of the flotsam of civilization. He also had quite a good collection of postage stamps. He was pleased to give his blessing to our travels, and wondered why we were so mad as to come to this desolate country for such crazy purposes.

Crossing the Chang La (18,000 feet) on May 22, we cut across the north end of the Pangkong Lake and reached Phobrang, the last village on this track. In order to reach the Changchenmo we had to cross a southern extension of the Karakoram by the Marsimik La—18,400 feet.

From here we had a gorgeous view of the snow ranges extending east and west, and also of the Ladakh Range, which runs between the Karakoram and main Himalayan systems.

On entering the Changchenmo Valley we encountered our first wild game of the Tibetan Plateau, the most numerous and characteristic of which is the wild ass, or, perhaps more correctly, the wild horse or Kiang. These thoroughbred little animals were always a source of joy to me, and I never wearied of watching them.

The problem of food for these wild asses is a puzzle. Spying a small herd feeding on a hillside, I marked out an area with my glasses and visited the spot. After much search I found a few blades of grass and an alpine plant or two. Measuring a space 100 yards by 10, I systematically collected every scrap of vegetation, and in the end had secured seventeen withered blades of coarse grass and seven small alpine plants, in fact, less than one would feed a guinea-pig on, and yet these herds of sheep and asses graze contentedly and with success on those barren hillsides. Their means of subsistence is still a puzzle to me.

We also saw near the Changchenmo the wild sheep, *Ovis hodgsoni* (the Ammon of sportsmen) and the Tibetan Antelope (*Pantholops*). These latter are of great interest, comprising a single-species genus peculiar to the Tibetan Plateau. The first party we saw were lying down, each animal in a small scraping which he had made for himself as a protection against the wind. Quite suddenly they all made off in different directions at a great pace, which is due to a biting fly coming among them. The Tibetan with me explained that they would all come back, so we waited, and sure enough back they all came from different directions and again lay down in their wind shelters. During the wait my Tibetan recounted a curious tale about these antelope. In the old days, if a Ladakhi came into the Changchenmo to hunt antelope, he brought with him a virgin, and the antelope, so delighted at the sight,

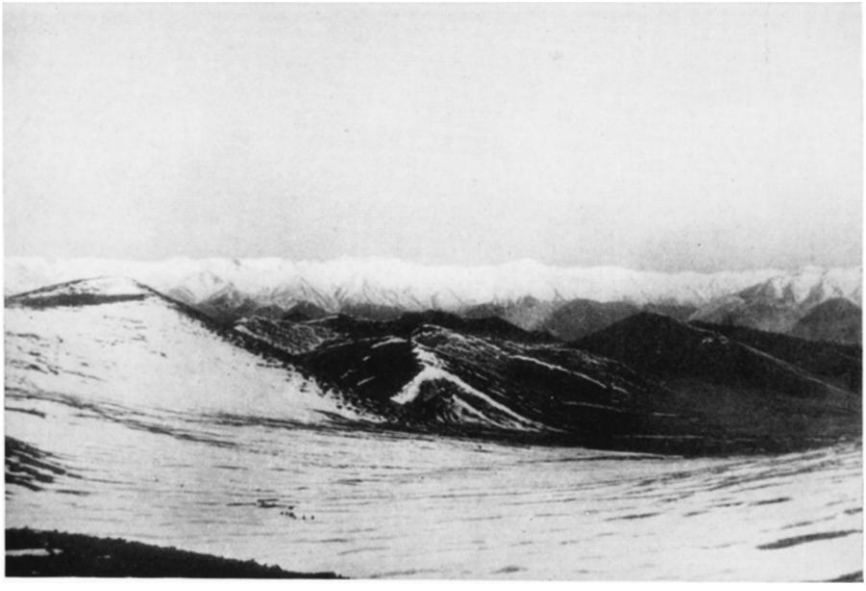
would all come up and lay their heads in her lap, when they were easily captured. I remarked that it was a pity we had not brought a virgin along with us. His sarcastic rejoinder was " I was referring to the old days."

It was in the Changchenmo that we were fortunate in seeing two snow leopard. They were crossing a stream, and to see the one pawing the icy water before he could take the plunge, and the other shaking the sparkling drops from his pelt after having successfully crossed, was a sight not easily to be forgotten. They were not over 30 yards from me, and quite unsuspicious—an unique opportunity for a right and left at this great prize among sportsmen.

We were fortunate in finding a sheltered spot for a camp in the Changchenmo, otherwise life would have been made quite intolerable by the incessant wind. Throughout Ladakh the wind was fairly bad, but in the Changchenmo it became a nuisance. Between 9 a.m. and 2 p.m. it would blow from the south-west or west. In the early afternoon it would veer round to the north. By sundown there were merely gusts from the north or a dead calm, but about 9 p.m. the wind would again spring up from the north and continue till it again changed to the west or south-west soon after daybreak.

I imagine the reason for these winds is as follows: The air of the Tibetan Plateau is highly rarefied and offers but slight resistance to solar rays. As the air becomes heated by the sun it moves slightly to the north, doubtless drawn in that direction by hot air rising from the Gobi and Mongolia. As noon approaches the velocity increases. I noted that on overcast days when the effect of solar rays would be felt less, the velocity of the wind was not so great, and also that as the sun sank the wind conformed. Westerly or easterly variation must be due to the rotatory movement of the Earth. The northerly night wind is probably due to cold air from Northern and Central Asia rushing in towards the plains of India, where there is little difference between day and night temperatures during the hot weather.

After a few days' stay in the Changchenmo, we retraced our steps to the north end of the Pangkong Lake and turned down its southern bank. The blue of the lake water was remarkable, excelling in depth of colour that of either the Cornish or Mediterranean Seas. It was almost a deep sapphire and not the usual turquoise blue. Though the water is salt there are many places along the shore where sweet water can be obtained. There are no boats on the lake, but it freezes every winter, when the local Tibetans take the opportunity of crossing on the ice and collecting firewood on the north bank, which is not inhabited. The lake is not prolific of aquatic life, though it contains fish, for a dead specimen was found. The presence of such fish-eating birds as goosanders is also evidence of fish in the lake. I found no trace of freshwater molluscs or shrimps, though these abound in all purely freshwater lakes in Ladakh.



Main Himalayan Range from the Chang La (18,000 *feet*)

The summit of the Marsimik La (18,200 *feet*), *E. Ladakh*

The northern end of the Pangkong Lake

Camp in Chanchenmo valley, E. Ladakh

Old beach-levels at the northern end of the lake were located at 35 and 46 feet above the present lake-level, and contained abundant freshwater shell fossils (*Limnæa*), a certain proof of freshwater conditions when the lake was at that level. At the north-west end of the lake where limestone is the predominant rock, sufficient lime has impregnated the lake water to congeal masses of pebbles along the shore, but this condition was not observed more than 18 feet above the present lake-level. The lake was therefore only 19 feet above its present level when it had an outlet.

The factors which went to form the Pangkong Lake seem to be two-fold. Primarily, land elevation which proceeded at a more rapid rate than river erosion could compete with; and secondly, a large alluvial fan from a tributary at the north end of the lake. There is evidence of both. The latest outlet was probably at the north-west extremity.

There is a curious shore-feature along the banks of the lake. Every few yards one comes across small lagoons, often landlocked by a bar of small pebbles. These bars are sometimes complete and sometimes with gaps. They vary from a few feet in length to over 100 yards. They are sometimes completely submerged and sometimes entirely above lake-level. The lagoons were in all cases deeper than the adjoining lake. They were usually situated at the terminal end of a dry watercourse, and at first I thought they were true bars. But some of them were formed across a re-entrant. What is the explanation? The prevailing wind on the lake is from the north, the depression in which it lies acting as a funnel and preventing the usual westerly or south-westerly wind blowing a true course. The small waves therefore break from the north and throw up these banks of pebbles: and in confirmation of this theory I noted that the bars were thicker and often more elevated on their north or exposed side. It was an effect of wind and water on the landscape, and gave to the shore a curious serrated appearance which I have only seen elsewhere on the west coast of Madagascar, though there the condition is on a much larger scale.

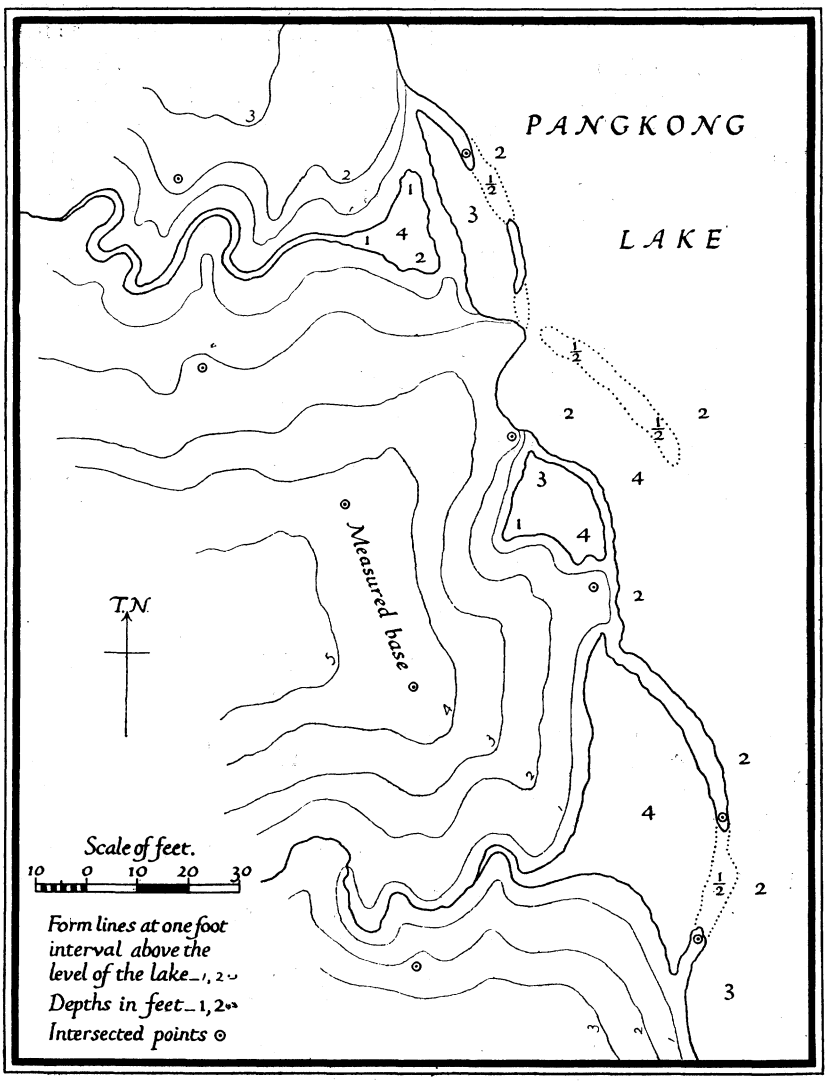
Leaving the Pangkong Lake at its south-west angle, we struck south to Shushal and crossed the Ladakh Range by the Kaksang La. Dipping down into the Indus Valley we crossed into Rupshu. On our way, and north of the Indus, we passed many small lakes.

The Mirpal Tso, not far from Shushal, lies in a deep depression surrounded on all sides by complete desolation. The bed of the lake is sandy and the water is fresh at the south end only. Freshwater shrimps (*Gammarus*) abound in the water-weed. Old lake-levels were noted at 27 feet above present lake-level, and wherever these were found a fossil freshwater shell (*Limnæa*) abounded. The lake to-day has no outlet.

Lake Yahia also lies at the bottom of a deep depression, but is fresh throughout, having an outlet into the Indus down a precipitous gorge. No high-level beach marks were noted.

The double lake known as Tso Kar lies in Rupshu on the left bank

of the Indus, and is of interest as its eastern or smaller half is fresh and the western half is salt, the two parts being connected by a stream. Twenty-seven old beach-levels were traced, the highest being 127 feet above present lake-level. The larger salt lake which has contracted a



Sketch-map of part of the shore-line of Pangkong Lake

lot by evaporation in recent years, has left behind it an extensive deposit of natron, similar to that found at Lake Magadi in Kenya Colony.

These Ladakh lakes are of course only a part of the great system of lakes which are spread over most of the Tibetan Plateau. They seem to

comprise two types, those which have been dammed by tributary alluvial fans, such as the Pangkong and Tso Kar, and others such as Mirpal Tso and Yahia, which seem to be pure rock basins, possibly scooped out by glacier erosion.

The many signs of much higher levels in Ladakh lakes, and indeed throughout Tibet, are proof of desiccation which is probably still proceeding. The greater rainfall of past ages is probably connected with the greater cold resulting from the Quaternary Ice Age.

Crossing the Taglaung La we descended the Gya gorge to the Indus, and arrived back in Leh early in July. We then struck north over the Khardong Pass and dropped down into the Shyok Valley, just above its junction with the Nubra.

This seems to be an opportune moment to introduce the yak, another mammal peculiar to the Tibetan Plateau and Kansu, and well adapted to the severe conditions to which he is exposed. Even on a cold day he shows signs of distress if hurried, and is only really in his element when an icy wind is blowing on a snowfield. The Tibetans maintain that the wild yak is quite a different species from the domesticated beast, but this is of course mere superstition which is of interest as showing that the yak was domesticated in the dim ages. The yak crosses freely with domestic cattle, the hybrid being called a Dzo. These Dzos give excellent milk, and are fertile *inter se*, but the offspring never attain maturity, always succumbing to a kind of vertigo when calves. The yak does not "moo" but grunts, hence his most appropriate name *Bos grunniens*. Many are hornless, and some of the quieter ones can be ridden.

They are nervous creatures, and quite small incidents alarm them. On one occasion after a 4000-feet climb, all my yaks were showing signs of distress, panting and grunting with their huge tongues lolling out. But on reaching the plateau, where they were faced by an icy blast, first one and then another commenced to frisk and buck like young goats, scattering their loads in all directions. The whole party became infected with exhilaration, and it was some time before they regained their composure and resumed their monotonous 2 miles an hour. But they are at their best in deep snow, and even though they sink in up to their bellies, they will gore their way through, seemingly to enjoy it thoroughly. And if they get too hot, they eat chunks of snow to quench their thirst.

Crossing the Shyok just above its confluence with the Nubra, we followed along the main Yarkand trade route, reaching the western foot of the Sassir La about Tutyalak on July 21, where we camped at 13,600 feet. The character of the Nubra Valley is quite different from that of the Indus Valley. Conditions are more favourable to agriculture, turnips, broad beans, peas, and apricots growing in profusion. The height is some 10,000 feet above sea-level, and abundant water pours off the Karakoram glaciers into irrigation channels.

Quite close to our camp was the ugly snout of the Mamostong (*olim*

Murgistan) Glacier, a black wall of ice scarcely recognizable as such. The height above sea-level of the snout is about 13,150 feet, and out of it flow two muddy streams which unite and form the Thulanbutichu River. The day on which I visited the snout was hot—78° F. in the shade at noon—and as the face and surface of the glacier were melting like a pat of butter in a frying-pan, I tried to measure the rate of decrease in ice. The face of the glacier at the snout was 214 feet high and about 1100 yards broad. As the ice melted under the strong sun, boulders and rocks embedded in ice became loosened and fell, which rendered the task difficult, as some of these boulders weighed from a ton upwards. Selecting a boulder which I located some little distance inside the ice, I dug down to it and found it was 4·8 inches in. In nearly two hours' time the boulder was flush with the ice-face, and after seven hours and two minutes the boulder, which was 19½ inches in diameter, had not only fallen out, but the rear of the cavity in which the boulder had rested was flush with the ice-face. The ice had melted 24·3 inches in that time. By using a similar method on the surface of the glacier, I ascertained that 11 inches of ice were lost in six hours.

Taking a sample of water from the stream which flowed from the Mamostong Glacier, I added alum, and after precipitation of all foreign matter was complete, three-tenths of the cubic contents were solid mud.

The Sassir La is of peculiar interest to the student of glaciers, as in that one area and from my camp I could see perfect examples of not only the " Valley " glacier but the less common type in the Himalayas, the " Hanging " glacier.

We explored the Sassir Pass on July 23, and wishing to see to what altitude plant and bird life would ascend in these latitudes, I selected an easy-looking spur north of the pass whence I fancied I might also be rewarded by a sight of K_2, but alas! though I had a superb view in most directions, on the north-west vision was blocked by a higher ridge. From what I saw it would seem that Mason (*Geogr. Journ.*, vol. **69**, No. 4, 1927, p. 319) is right in treating the Nubra–Upper Shyok divide as a continuation of the main Karakoram Range. At 18,800 feet I noted a flock of swifts feeding off some small insect which I could not detect. At 19,950 feet I shot a raven which showed undue inquisitiveness in my movements, whilst at 21,050 feet, the highest point I reached, I was delighted to find a family party of wall-creepers (*Tichodroma*) which had probably been bred at that altitude.

Mention can now conveniently be made of the influence of altitude on the human body. When in Ladakh I had the advantage of having a copy of Major Hingston's admirable paper on this subject with me (*Geogr. Journ.*, **65**, 1925, pp. 4–23).

The following observations were made on my own system:

	Pulse sitting.	*Pulse standing.*	*Time breath held.*
Sea-level	.. 76 ..	.. 76 ..	.. 110 secs.
11,500 feet ..	.. 78 ..	.. 81 ..	.. 58 ,,
15,000 ,, ..	.. 78 ..	.. 92 ..	.. 42 ,,
18,000 ,, ..	.. 86 ..	.. 98 ..	.. 39 ,,
21,050 ,, ..	.. 104 ..	.. 118 ..	.. 22 ,,

My respirations at sea-level are normally 14 per minute in a sitting position, whereas at Leh, at 11,500 feet, they were increased to 18, and at 18,000 feet to from 22 to 26.

I believe each individual has an altitudinal limit beyond which he cannot go without distress. Mine is 14,200 feet, and I had many opportunities of testing it. It will be found to vary in individuals from between 13,000 to over 15,000 feet. At over 14,200 feet I found breathing irregular—that is to say, there was an alteration in rhythm, especially when one first lies down. I seldom noted it when moving. This irregularity was often accompanied by hard jerks at the heart.

When walking on the flat or climbing at over 18,000 feet I could ease my breathing considerably by taking deep breaths at every step—that is to say, by inhaling more air than I should normally do. I breathed, in fact, as though I was out of breath and found it a great help. If I rested at over 18,000 feet I experienced greater breathing and heart distress than if I walked slowly. It therefore does not appear that the discrepancy between oxygen supply and oxygen demand is entirely responsible for lung and heart distress at high altitudes.

We all suffered from sore throats, which were attributed to increased passage of very dry air.

The general lassitude at over 15,000 feet was most noticeable. Movement defeated physical lassitude, but mental vacancy was more stubborn. One often felt inclined to sit in camp and do nothing. This was accompanied by a vacant brain which made writing an effort, but our memories did not seem to be affected.

Loss of appetite was the most serious consequence of continued sojourn in high altitudes, and this accounted for general physical deterioration and loss of weight. I lost over 16 lbs. in the first three months. At times we positively disliked food of any sort, though we had ravening appetites. The first mouthful seemed to allay the worst hunger. A small glass of wine was an excellent stimulant on those occasions. Sweet foods were most popular, especially marmalade, and we preferred liquid foods to solids. Meat in any form was distasteful.

Thirst was at times almost intolerable and quite unquenchable, this being due to the dryness of the air and not to heat. We found that large quantities of hot sweet tea were the best remedy.

The ultimate result of prolonged residence in high altitudes is affection of the nervous system. Slight headaches, insomnia, mental and physical lassitude, and, to a minor degree, indigestion are probably all the result

of the nervous system getting out of order. Intestinal flatulence, so common in Ladakh among my party, was also the result of the same conditions. Insomnia was a great inconvenience, but was not most acute at extreme altitudes. I would sleep well at 18,000 feet and get little sleep at 15,000 feet. In fact, I think I always felt altitude more between 14,500 feet and 16,500 feet than above the latter elevation.

We never became acclimatized to high altitudes, suffering as many inconveniences during the last month as we did during the first week. But it seems that aviators do become acclimatized, their systems adjusting themselves to the abnormal conditions. This is not easy to explain unless one accepts the theory that oxygen can be secreted in the lungs. And this theory seems possibly correct, for it would explain why the members of the Everest Expedition benefitted so slightly from administered oxygen.

We found tobacco beneficial, steadying the heart's action and respiration. Though I continually smoked a very strong tobacco and Burmese cheroots, no evil effect was experienced.

Alcohol when at rest was useful as a stimulant or appetizer, but on the move was definitely harmful.

High altitudes have a great effect on bacteria of all sorts, infectious diseases being almost unknown. Malaria, tetanus, cholera, and rabies have seldom if ever appeared in Ladakh. Cancer is almost unknown. Septic wounds following on operation are almost unknown in Leh at the Mission Hospital, but operations of a serious nature usually mean heart failure and death.

And now let me advert to Major Hingston's paper on " Life at High Altitudes " (*Geogr. Journ.*, **65**, 1925, pp. 185–198). I need hardly say that it gave me very real pleasure to read that paper. The writer's unrivalled powers of observation and his attractive style have always excited my admiration. But I cannot agree entirely with the substance of Major Hingston's paper. He has noted many peculiar adaptations of Nature to environment and rather labours the point that high altitude is the responsible factor. This aspect of his paper is, I venture to suggest, misleading.

He very truly says in his paper " Tibet is essentially a desert." I would add, a high-altitude desert. And it is the only place in the world where one finds both Arctic and desert conditions exerting influence over life in the same area.

It is of course true that animals in Tibet and in all deserts, and in fact in nearly every region of the Earth where animal-life lives under exposed conditions or where it is exposed to danger from enemies, Nature, or some such force, tends to render it inconspicuous. Instances could be enumerated *ad nauseam*. Protective coloration is the term usually employed for such conditions. The phrase is unsatisfactory, as " protective " implies purpose which probably does not exist except in

the guise of Natural Selection. A term such as Environmental Mimicry is probably more apt.

But though the curious resemblance between the colour of animal-life and the colour of the environment in which that life lives, establishes the fact that there is such a condition as environmental mimicry, why is it that certain nocturnal rodents in low-lying deserts, and also a bat in Ladakh, have this peculiar pale grey desert colour which their habits preclude them from using to advantage? And why is it that some birds and some mammals have not been influenced to the same extent and stand out amid their surroundings as conspicuous objects? It is agreed that environmental mimicry exists where it is needed. But the causation is still an unsolved problem, probably of a chemical nature. In some cases increase in pigmentation is a definite reaction to increased rainfall, in other cases it is as definitely not so. In some cases the character of the soil, rock, or other surrounding on which the animal lives, exerts an influence on the plumage or pelage: in other cases it is definitely not the case. But whatever the force or factors are, the laws of environmental mimicry are not confined to either deserts or high altitudes but are world-wide, wherever and whenever protection is vital to existence. If it were not so, competition in some form would overwhelm that species to whom environmental mimicry had not been extended.

Protection against wind and cold is provided for by an increased thickness of feather or fur, and here again the law is universal. Whether in the Arctic or Antarctic, on the Central Asian Plateau or in the Alpine zones of tropical Africa, we find the same law applying. The Scottish Mountain Hare has denser wool than the Brown Hare. Thomson's Gazelle of the Aberdare Mountains in Kenya has a longer pelt than the same species on the lower-lying Athi Plains. The Coal Tit of Kamchatka has denser plumage than the Coal Tit of Japan, and so on.

Major Hingston noted an interesting case of the Short-toed Lark building a rampart of pebbles on the exposed side of the nest, presumably to help in keeping off the wind. Other larks in Algeria, Palestine, 'Iraq, and elsewhere where winds and dust prevail, do precisely the same thing and for precisely the same reason, the habit not being born of high altitudes but of wind.

Major Hingston makes special mention of the Chough and its powerful bill, which he suggests is specially adapted to the frozen soil of Tibet. The Chough in Cornwall, Crete, or Morocco, where contact with frozen soil is exceptional, has precisely the same development of bill. It may also be added that the Chough in its present form as regards structure, almost certainly existed before the Tibetan Plateau came into being.

It is stated on p. 191 " that the peculiar environment of the Tibetan Plateau has caused some of the high-altitude birds to change their

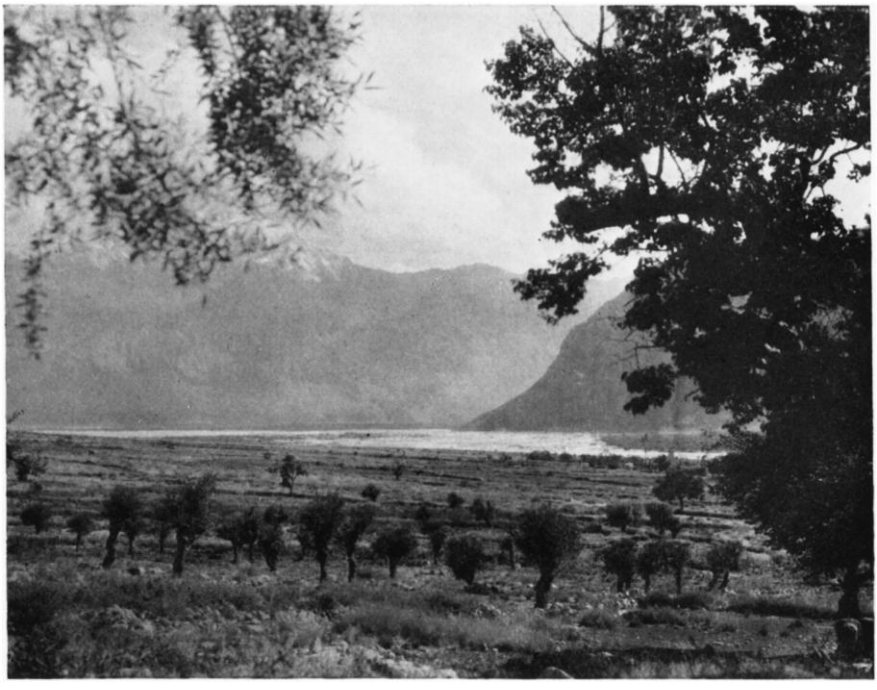
customary habits of life." The Tree Sparrow is quoted as having become an exclusively village bird, owing to the absence of trees. But the Tree Sparrow, except where he has been driven from villages by the House Sparrow, is essentially a village bird, whether in Baluchistan, Persia, Turkistan, Siam, Japan, or Singapore. It is not climate but competition which has induced the Tree Sparrow to leave his favourite abode, human habitations.

I would suggest that Major Hingston has attributed to high altitude certain habits and adaptations of life to environment which are in fact world-wide and not peculiar to the Tibetan Plateau.

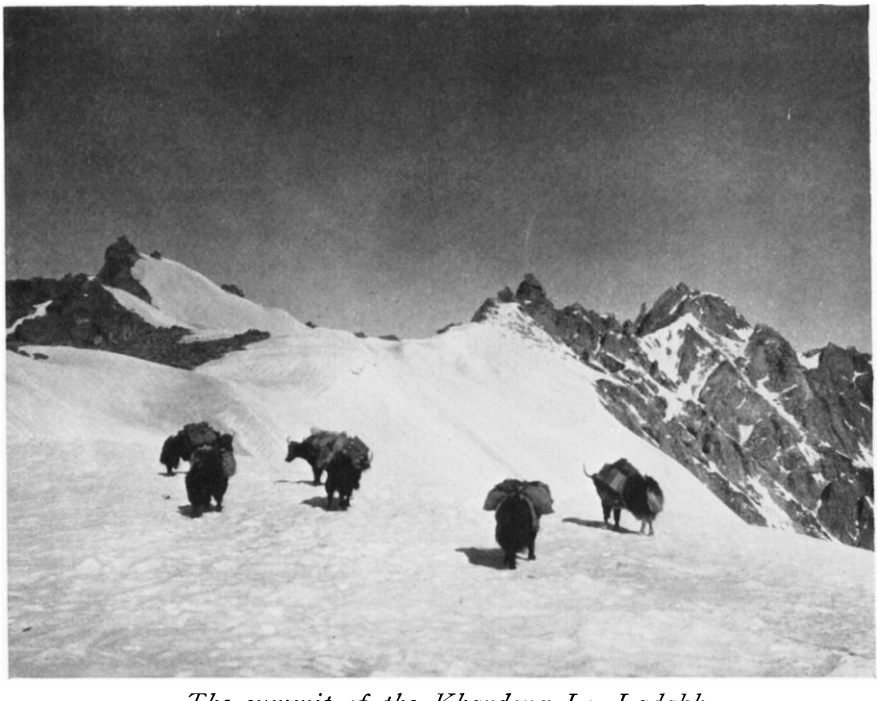
But there is one aspect of Tibetan Plateau life to which we must all wish Major Hingston had addressed himself. Those other portions of the globe which most nearly approach Tibet in climate are the Arctic and Antarctic. In Tibet and the Circumpolar regions we find many species of birds and mammals which live amid glacial conditions, and the effect is remarkably different in the two regions. In the Arctic we find all animals to whom environmental mimicry is essential, adopting a white garb, sometimes throughout the year and at other times only in winter. The only terrestrial animals which do not do this are those which do not need it. The musk-ox does not require protection and does not turn white. The raven, also a resident on the last remnant of the Ice Cap in Greenland, requires no white plumage, having no enemies. But other forms of animal-life, whether falcons, owls, foxes, or polar bear, which require environmental mimicry for aggressive purposes, or ptarmigan and hares which require similar adaptation for purely protective purposes, adopt a white garb in the Arctic.

This remarkable reaction to glacial conditions is not confined to the Arctic. In Scotland the Mountain Hare, the stoat, and the ptarmigan assume a white livery in winter. Among mammals this change is brought about by depigmentation of the fur, probably slightly assisted by moult.* Among birds it comes about by moult alone. The return in spring to normal conditions comes about invariably and entirely by moult among both mammals and birds. It is also an established fact that winter whitening is accelerated by early snow or frost. In the north of Scotland the stoat always turns white in winter; in the south of England winter whitening is of rare occurrence, intermediate areas disclosing intermediate conditions. The cold snap which occurred in the last fortnight of October 1926 had the effect of causing the stoats of Mull to assume their winter coat at least a month earlier than in 1925. Again, the Irish hare, but a geographical race of the Scottish hare, seldom turns white, living in a more temperate climate, and this character is so per-

* A Scottish hare kept alive in Cambridge during the autumn of 1899 by Barcroft, had turned almost completely white by January 1900 (*Proc. R. Irish Acad.*, **24**, B, 1903, pp. 303–314), but though it was under close observation no trace of moult was detected.



Junction of the Nubra and Shyok rivers, Ladakh



The summit of the Khardong La, Ladakh

Snout of the Mamostong Glacier, west of the Sassir La

The Karakoram at 21,050 *feet, above the Sassir La*

manently impressed on the race that even if transported to the territory of the Scottish hare winter whitening is still not the rule. It is significant that the Brown Hare (*Europæus*), which never shows decided winter whitening in the United Kingdom, often turns partially white amid the severer conditions of Northern Europe.

Again, our Red Grouse, which is but a geographical race of the Scandinavian Willow Grouse or Rhyper, never turns white in Scotland, though Caithness and Sutherland birds show a tendency to more white on the under parts in winter than is usual among, say, Yorkshire birds. In Scandinavia all Rhyper turn white every winter.

We see that in Northern Europe and in Circumpolar regions animal-life conforms to certain laws when the application of that law is necessary to existence. But on the Tibetan Plateau, where winter conditions closely approximate to those of the Arctic and are infinitely more severe than those of Northern Europe, we have no single case of winter whitening.

To what is this due? It seems that cold alone does not produce winter whitening. Snow is necessary. The Tibetan Plateau in winter, though gripped in the iron grasp of frost, is not snow-bound. Winter whitening would be a disadvantage to Tibetan animals, and it therefore does not occur. That terrible struggle for existence which reaches to a very high pitch on the Tibetan Plateau is centred round desert conditions and a very low temperature. In the Arctic it is centred round snow and the general whitening of the environment. Winter whitening of animal-life would not help in Tibet, and therefore does not occur. It is vital in the Arctic, where we find it to be almost invariable.

To return to our route. Retracing our steps into the Nubra Valley we tried to pass down the Shyok to Skardu, but floods compelled us to abandon the project. Three days of heavy rain turned every watercourse into a raging torrent, and it was only by wading breast-high along the banks of the Shyok that we were able to get out of the valley at all. We returned to Leh on July 31, and eventually reached Skardu by the Indus Valley.

Let me here refer to some interesting aspects of the Ladakh climate. A country devoid of vegetation means a paucity of soil. Storm water seldom soaks in, but comes roaring off the hills in flood. This produces the alluvial fans so characteristic of Ladakh valleys. The fan can be seen wherever a tributary valley joins a main valley, and is formed by a mass of water-worn boulders which for ages have been accumulated where the torrent debouches from the hills. An aerial photograph would be necessary to illustrate them to advantage, and as the fans caused by dredging on the Suez Canal are of precisely the same nature, an air photograph of one of these will show the formation equally well.

These fans are sometimes well over a mile in diameter at the base, and always much higher in the centre than at the sides. One which I measured in the Nubra Valley was 2040 yards across at its base, with

its centre raised 98 feet above natural ground-level. When in flood the torrent tears down the centre. In dry weather there is either no water at all or a mere trickle which is usually to be found at the edge of the fan. It is near these fans that villages are always situated.

Lowest levels of continuous snow were noted as follows:

Locality.	*Date.*	*Lowest Level of Continuous Snow-field.*
Namika La, Ladakh	26 iv.	.. .. 12,200 feet.
Marsimik La, Ladakh ..	29 v.	south slope 17,800 ,, north slope 16,200 ,,
Chang La, Ladakh	22 v.	south slope 17,200 ,, north slope 16,000 ,,
Khardong La	14 vii.	south slope 17,600 ,, north slope 16,400 ,,
Khardong La	31 vii.	south slope none north slope 17,100 ,,
Sassir La, Karakoram ..	23 vii.	.. .. 17,400 ,,
Zoji La, Kashmir	4 iv.	north slope 8,750 ,, south slope 10,600 ,,

In North Sikkim, which was visited in the following winter, snow was down to about 11,000 feet on Kangchenjunga in November, and down to below 10,000 feet in December and January.

Part II. The Origin of Life in the Himalayas and on the Tibetan Plateau

In order to arrive at the origin of life in the Himalayas and on the Tibetan Plateau, it is obvious that we need not push our inquiries farther back in the history of the world than the period when the Himalayas did not exist. In the first place we will deal with the purely geological aspect.

It is now generally conceded that Peninsular India was not connected with Continental Asia during early Eocene times, that is in early Tertiary. At that period there was no high land mass in Central Asia, and in fact vast areas of that region were ocean bed. Peninsular India may or may not have been connected through Gondwana to Madagascar and Africa.

In early Eocene times the Bay of Bengal reached far to the north, covering parts of Assam and the Eastern Himalayas, and the Indian Ocean stretched over the whole of Persia, Baluchistan, Afghanistan, the Indus Valley, and probably parts of the Ganges Plain. An arm of the sea reached up into Ladakh and Western Tibet. In Northern India the sea came at least as far east as Dehra Dun.

Thrusts from the north now pressed against Southern Asia, and being checked by the Salt Range in the west and the Assam Hills in the east, the Himalayas were squeezed up against those checking obstacles and the northern border of Peninsular India. This caused a gradual rise in Northern Assam which gave birth to the Eastern Himalayas

and appears to be the first connection which India had with Asia (or ancient Angara), a condition which allowed all the forms of life which had been developing in Central Asia to migrate south into the Indian Peninsula. And during this period of general low levels the monsoon without doubt could pass unchecked into Central Asia, causing considerable precipitation, rendering Mongolia and the Gobi fertile areas and great centres of development and distribution. This may be regarded as the first phase of the Himalayan uplift.

In the Miocene the ocean bed still covered Sind, but where now stands the Himalayas and Tibet one might have seen land of moderate elevation, intersected by huge rivers flowing from east to west and discharging into Tethys or the Indian Ocean. No marine fossils of Miocene Age have been found in the Punjab or sub-Himalayas, all deposits seeming to be fluviatile.

In the Middle Pliocene occurs a second phase of uplift, which was responsible for the main upheaval and determined the main trend of the ranges and the lines of watershed. As the plateau rose, so did the Tertiary seas (Tethys) of Central Asia drain away into the Indian Ocean, but the Himalayas commenced to form a barrier to the moisture-laden winds of the south-west, resulting in a slow process of desiccation which has probably not yet reached its maximum degree.

The third phase of uplift took place in the Upper Pliocene and was responsible for the Siwalik Range. Elevation by pressure or thrust continued not only through the Pliocene but far into Pleistocene times, and may still be at work. There is, in fact, evidence to show that during the Quaternary Glacial period, that is to say, some 20,000 years ago, the Himalayas and Tibetan Plateau were not so elevated as they are to-day. And they may still be rising.

Let us now examine the relation between animal-life and geology during the period of uplift of the Himalayas and Tibet. Geography is the determining factor in animal and floral distribution. Climate and geography are so intimately connected that as factors they must be considered co-equal. though exerting quite different influences on animal-life. The distribution of life is entirely dependent on the changing of the land surface of the globe, a fact which brings zoology and geography into such close union. There is, therefore, no necessity for explaining why it is necessary for me to go rather deeply into zoological questions before this Society, for, though geography dominates animal distribution, it is often the latter, under the guise of palæontology, which gives us the clue to the distribution of land and sea in ages gone by.

When the Himalayas and Tibet were still submerged below the ocean, nearly all the more comprehensive groups of animal-life already existed. The huge Dinosaurian reptiles, having reached their zenith in evolution, had gone for ever, having probably succumbed to changed climatic conditions. Whales, rodents, insectivores, the true cats, and in fact

nearly all groups of modern placental mammals, except the true oxen and the bears, existed when the Himalayas and Tibet were at or below sea-level.

The nature and distribution of flora in a country is, in the last resort, the determining factor which decides what types of animal-life can live therein. It cannot therefore be ignored. When the Himalayas were still in their infancy, or even before, such modern trees as the oak, plane, tulip tree, beech, alder, and poplar were in existence, as also were flowering plants. The floral landscape of the country was therefore not very different from what it is now, except where the hand of man—alas! almost throughout the globe—has changed it for the worse.

As India, from late Eocene to Miocene, became more and more a part of Asia, but with the Himalayas not a barrier to migration as it now is, and with a large fertile, well-watered area to the north teeming with life, where now all is desert and desolation on those wind-swept, desiccated, sand-covered wastes of Mongolia and the Gobi, so did all branches of life migrate south or spread south into this new land. During the Miocene and Pliocene nearly all the great African mammals could be found in Northern India. In fact, they were all then slowly moving south to where they are found to-day in modern Africa, Arabia at that period being connected with South Persia and Africa through the mouth of the Persian Gulf and Somaliland. India in the Pliocene could not have been distinguished from Africa of to-day, in regard to the larger mammals. And even more, the chimpanzee lived in the forests of the Punjab and the wild camel roamed the plains. The tiger had also come in from Siberia and the dawn of man was imminent.

But the Himalayas and Tibet were fast rising, cutting off the rain from Central Asia, converting that country into a desert, and isolating the Indian Peninsula from further migration of animal-life. In fact at the present day, except on the eastern frontier, India is so effectively isolated that even man has difficulty in gaining access to those countries beyond its borders. For all intents and purposes India is an island on the south coast of Asia, and despite the raising of the largest land-mass the world has ever known on its northern frontier, and which has connected it with Asia, it is still as isolated as it was before connection with Asia took place.

And then came an event which compelled all forms of life in the Northern Hemisphere to adopt two alternative methods of self-preservation. I refer to the Glacial Period. All forms of life had to decide whether they would adapt themselves to the new rigorous conditions, or migrate. To do neither was to perish, and much perished.

To what extent did the Ice Age affect Central Asia and India? We have two classes of evidence, the one primary and the other secondary. Our primary evidence is glaciation. What evidence is there of glaciation in Central Asia and India? The answer is that evidence is scanty

because intensive geological surveys have not as yet been carried out. Moraines and other signs of ice-flow have been found as low as 4700 feet in Kashmir and as low as 3000 feet in Kangra. There is also ample evidence to show that the present Himalayan Glaciers are but the disintegrating residue of older and more extensive glaciation which embraced not only the whole of the Himalayas, but the Tibetan Plateau. The Pir Panjal contains a mass of evidence of Pleistocene Glaciation. And furthermore, ice-borne boulders (wether-stones) have been located at Potwar, near Rawalpindi, which have without a doubt been carried in ice by flood water from the Himalayas into the plains of India.

In Ladakh signs of previous glaciation in the form of terminal moraines were observed commonly, not only in the Indus Valley at about 10,000 feet, but in the Nubra Valley at about the same elevation. At one spot near Tegur in the Nubra Valley there were obvious signs that a valley glacier had crossed the valley flowing from the east and had bumped its snout up against the cliffs on the west bank of the Nubra. That must have formed an extensive lake and would account for many signs of a former lake-bed around Panamik and farther north.

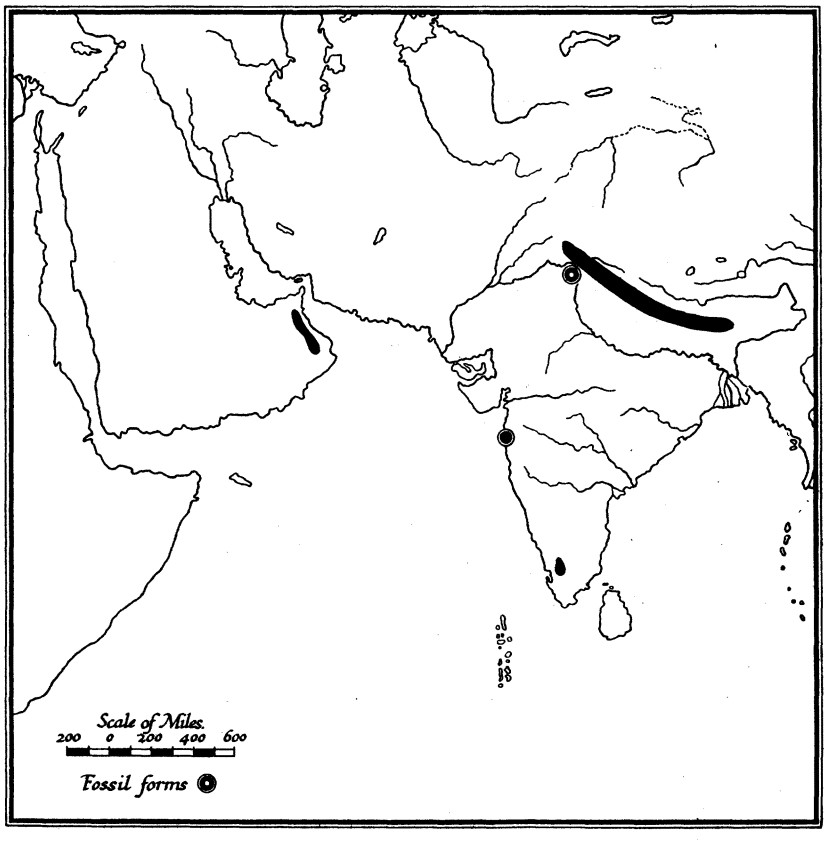
Evidence left by an ice-cap or extensive glaciation is unmistakable and abundant, as any geologist may know who has read the story of the Ice Age in Scotland. Extensive evidence of such a nature simply does not exist in the Himalayas, nor on the Tibetan Plateau. We may therefore assume there was no great ice-cap such as once existed in North-West Europe or as exists to-day in Greenland. But the absence of an ice-cap does not mean the absence of intense cold. No snow, no glaciers, and no tell-tale scratches on the ice, but the cold might have been as intense as existed in Northern Europe during the Ice Age.

It is a difficult and complex subject, about which we have not yet sufficient evidence on which to base much more than a superficial judgment. But for the purposes of this paper I would ask you to accept the opinion that the Glacial Period did not extend in an acute form beyond the confines of North-West Europe, and that it exerted a refrigerating influence not only over Southern Europe, but also over Western and Central Asia, and probably almost certainly over the Indian Peninsula; but that ice-caps (*in sensu stricto*) did not form on the Tibetan Plateau owing to lack of precipitation.

Secondary evidence of the effect of glacial conditions in Central Asia and India can be gleaned from a study of the distribution of animal-life as it stands to-day, but though we have the facts, evidence of this nature is not entirely reliable, as we are not certain what are the real causes of distribution. Distributional evidence, unless very carefully sifted, is a trap into which many have fallen. We shall try to obtain the significance of a simple case of discontinuous distribution which illustrates our argument.

In the Himalayas from Kashmir to Bhutan lives a goat-like animal

known as the Thar (*Hemitragus jemlaicus*). It is represented in the hills of Southern India by what is known as the Nilgiri Wild Goat (*Hemitragus hylocrius*). Again, in the hinterland of Oman lives another form which has been called *Hemitragus jayakeri*. Fossil forms of the same genus have been found in the Siwaliks and on Salsette Island. It may be taken as an axiom of distribution that all forms of life tend to increase and expand where suitable conditions exist and where there is no prohibitive competition. It is also another axiom that a discontinuous



Distribution of Hemitragus (Thar)

distribution represents isolated colonies of a once-continuous distribution, and that the genus or species whose distribution is discontinuous is usually more ancient than allied genera or species whose distribution is continuous.

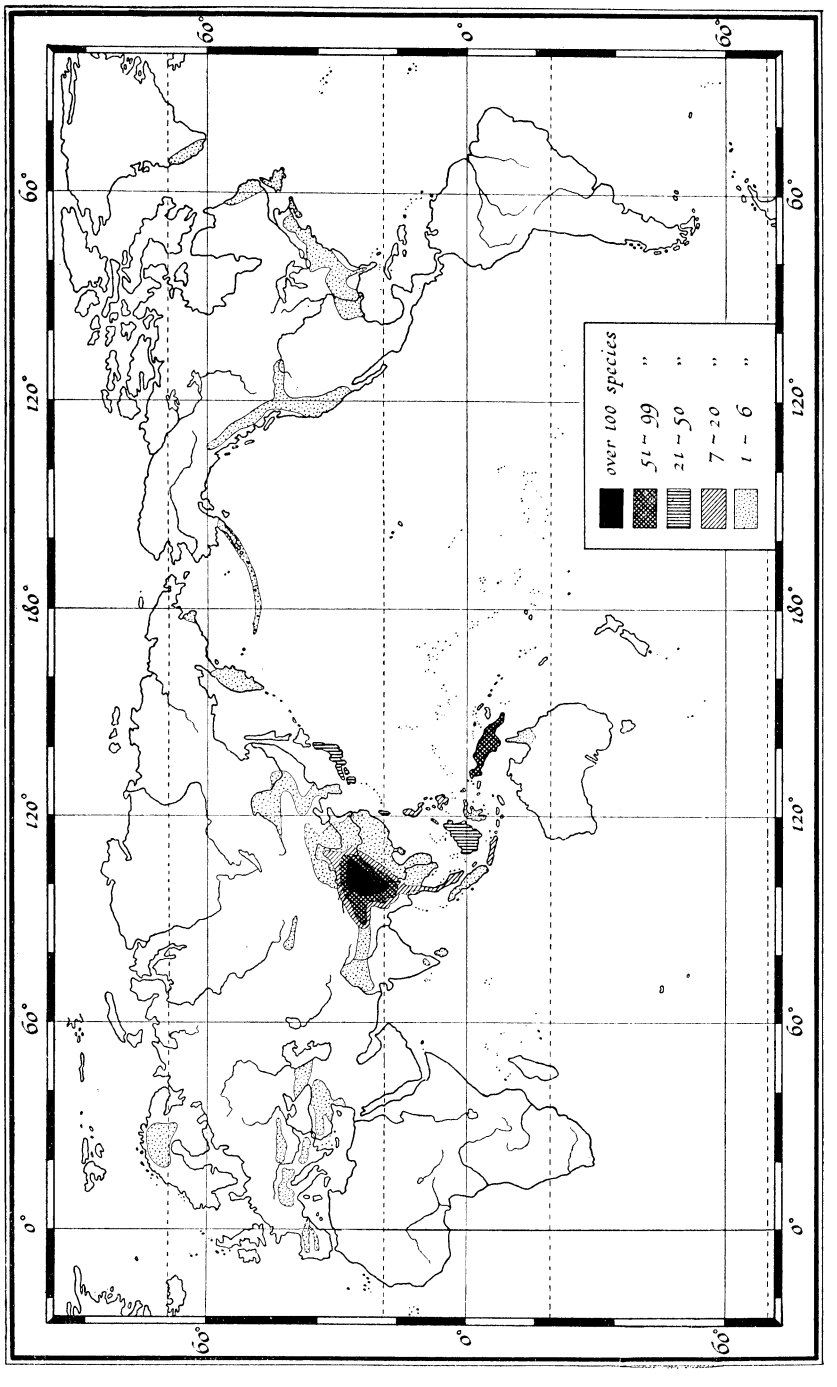
The significance of the distribution of living and fossil Thars is therefore that either suitable conditions for the Thar once existed in North and Central India and east through Persia and Southern Arabia, or that some such influence, as glacial refrigeration, compelled the Thar

to move south and west, and that with the cessation of refrigeration the Thar moved north again and reoccupied its old home. To accept the second alternative means that the Thar migrated south over the plains of India, for during the Pleistocene Indian physical geography was not very different from what it is to-day. Such a migration is unthinkable, and we must look further back in the history of India to find conditions suitable for the Thar in Central India. We must hark back well into the Tertiary, possibly to the Miocene, before we can find conditions which allowed the Thar to live in one unbroken distribution from Cape Comorin to the Siwaliks and from Bhutan to Oman. Competition in some form, physical or climatic, has exterminated the Thar in all intervening areas and left us with a few relic colonies. The Thar therefore probably existed in much its present form before the Himalayas had risen. It seems doubtful whether the refrigeration of Southern Asia during the last Glacial Period had much influence on modern distribution. It is, however, significant that the extinction of the Siwalik mammals coincides with the Glacial Period. It is by no means certain that the one caused the other.

Types of life are confined to particular types of country which satisfy their needs. Where those types of country do not exist, it is futile to search for those types of animals which affect them. A change of climate may compel life to migrate, but if it moves into an area unsuited to its habits, it must perish or adapt itself to new surroundings. As far as we know, the Thar has failed to adapt itself to any other country but precipitous mountains, and has perished in those regions which have changed their conditions and become unsuited to its habits. The Thar has failed to compete with competition, which brings us back to Darwin's theory that it neither was nor is fit to survive in those regions except when they are entirely suited to its habits. The present distribution of the Thar is a good example of the force termed natural selection or survival of the fittest. Eliminate that force, and the Thar will thrive in captivity at sea-level.

The Thar is not alone in having an isolated colony in Southern India. In the genus *Rhododendron*, with nearly 900 known species, we find an isolated colony in the Nilgiri Mountains. Here again we must presume that at one period the rhododendron extended throughout India, but has been exterminated by competition in intervening areas. Where plant-life is concerned there is always the possibility of seeds having been carried by wind or birds. The distance is too great for either contingency. The seed of the rhododendron is too heavy to allow it to be carried by wind for more than a few miles, and the digestion of a bird is too rapid to allow a seed to remain in its intestines for the period required in flight for 1600 miles.

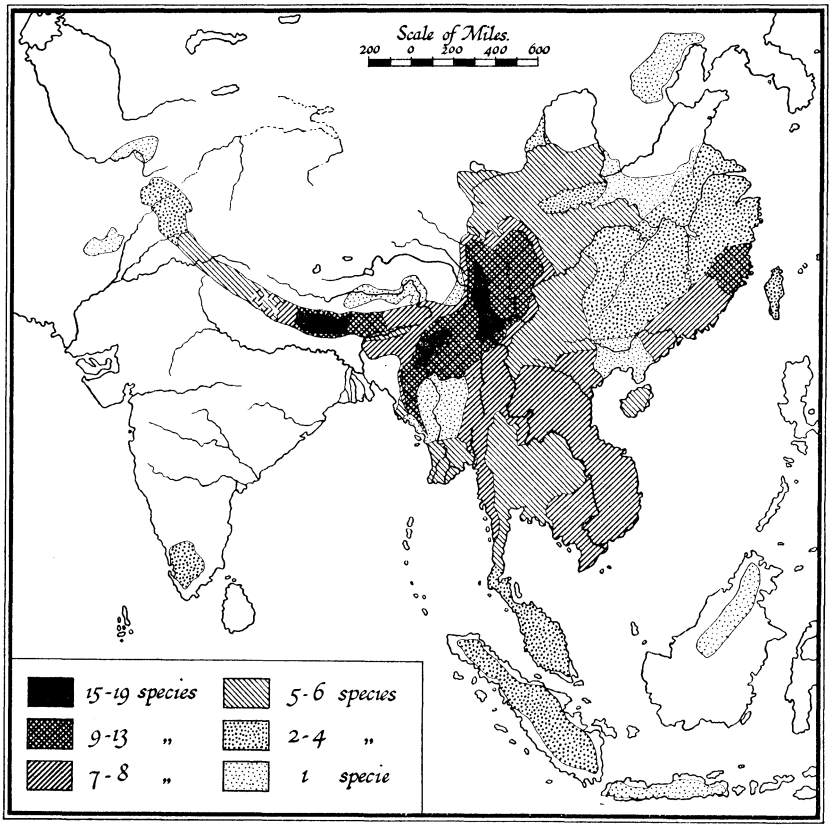
We find a similar distribution among certain insects and among several groups of birds, the most striking of which is that of the genus



Distribution of the Genus Rhododendron

Garrulax, or Laughing Thrushes. These remarkably similar distributions are probably the result of similar causes. The Nilgiri colonies of Himalayan life are relic colonies of a once continuous distribution which existed long before the effect of the Glacial Period was felt in India, and the Himalayas are probably as much a refuge for the Thar, Rhododendron, and Laughing Thrush as are the Nilgiri Hills.

What of the climate during the Himalayan uplift? All evidence



Distribution of Genus Garrulax

seems to point to there having been an almost tropical climate in what are now the Arctic regions during the Lower Eocene and Miocene, and this must have meant a climate not less cold in Central Asia and India. In fact, throughout the Northern Hemisphere the climate of the Miocene was both warmer and more uniform than it is at present. There is also evidence to show that as late as the period immediately preceding the last Glacial Period the Arctic was more temperate than it is to-day. The Mammoth, Woolly Rhinoceros, and Long-haired Tiger have all been found in a frozen condition with their wool still adhering, in Siberia,

the last-named as far north as the now isolated New Siberian Islands. We may therefore assume that when the Himalayas and Tibetan Plateau were in their infancy the climate was warm and uniform, slowly becoming colder and colder as they rose and as the Glacial Age approached, but with a gradual resumption of warmer conditions as the northern ice-caps receded.

So much for the origin of the Himalayas and Tibetan Plateau and the effect of the Glacial Period on contemporaneous life. We must now consider how the Himalayas and Tibet were colonized by the life which exists there to-day.

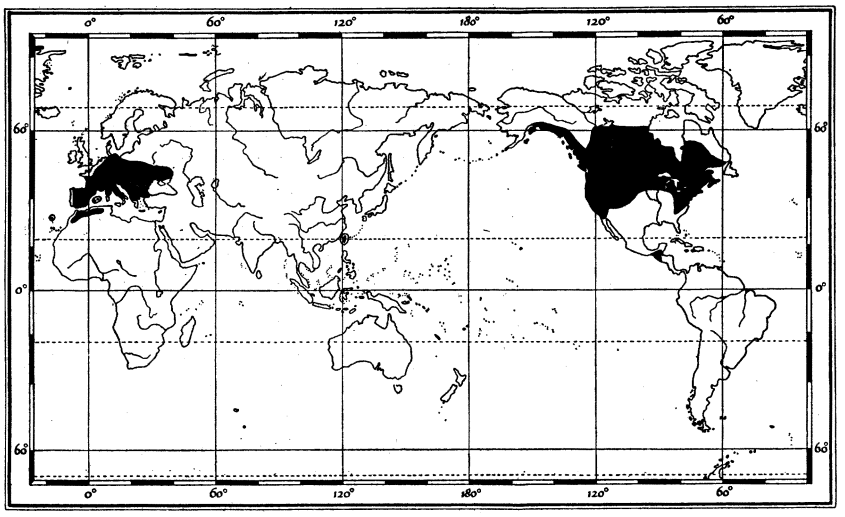
When the Himalayas and Tibet were yet at sea-level birds in more or less their present form existed. Good evidence of this is to be found in certain modern distributions, such as that of the Fire-crest Wren or the Blue Magpie. Here we find small island-like colonies with enormous distances separating them. And that is all that remains of a once continuous distribution from China to the Atlantic, a distribution which must have existed at the same time as when the Mediterranean was connected with the Chinese and Japanese Seas through what is now Central Asia, for how else can one account for the striking similarity between the fish of these now widely separated seas? More than half the generic types in Japanese waters occur also in the Mediterranean, and in many cases even the species are identical.

But what form of life first colonized the Himalayas is not known and never can be known. It certainly has little to do with life as we find it to-day, for conditions were very different. To speculate on such a subject is pure guesswork and unproductive. We shall therefore confine our inquiries to life as we find it to-day.

Tibet and the Himalayas can be conveniently divided into three sub-regions; the Tibetan Plateau, Kashmir, and the Himalayas from Southern Kashmir to Bhutan.

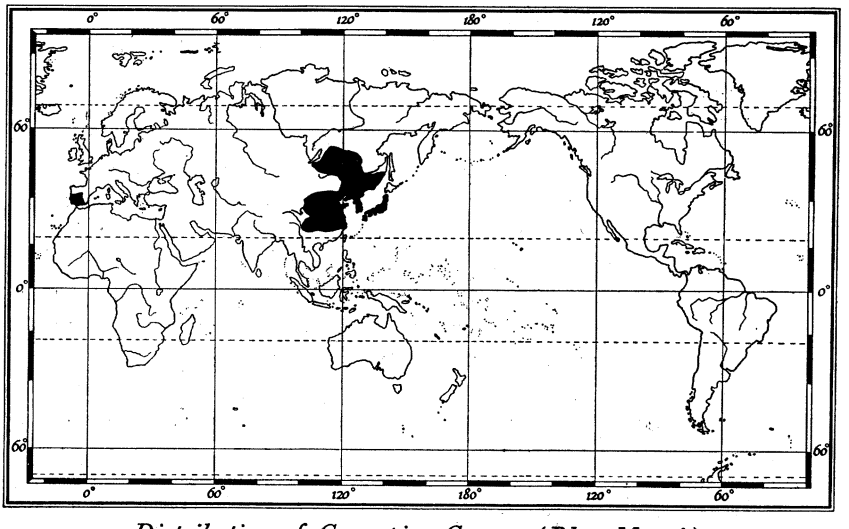
I shall first deal with the true Himalayan sub-region, namely, the hill tract extending from Southern Kashmir to Bhutan, bounded on the north by the tree-line and to the south by the foothills. This is neither the time nor place to enter into details. Suffice it to say that all evidence points to the afforested area of the Himalayas having been colonized from the east, that is to say, from the Chinese Hills. If one studies the distribution of genera or species of mammal, bird, or plant, and maps it out, this becomes abundantly clear. The cases where colonization might have come from any other quarter are rare and doubtful. There are, of course, many examples of infiltration from the plains of India, but in these cases the colonists have never reached any altitude. In most cases where there are many species of the same genus inhabiting the Himalayas, for every species at say Simla there will be two or more in Sikkim, and a still greater proportion as one nears the great centre of dispersal in Yunnan and Szechwan. This is well exemplified by the

distribution of the two genera *Rhododendron* and *Garrulax*. In *Rhododendron* we find 447 species in Yunnan and Szechwan, 40 in Sikkim and Bhutan, 6 in the Central Himalayas, and only 3 in Kashmir. In *Garrulax*



Distribution of Regulus Ignicapillus (Fire-crested Wren)

we find 19 species in Yunnan, 15 in Nepal and Sikkim, 6 in the Central Himalayas, and only 4 in Kashmir. It may be argued that the distribu-



Distribution of Cyanopica Cyanus (Blue Magpie)

tion of these two genera are governed by humidity. That is probably true, but does not alter the fact that they have spread along the Himalayas from the east. And the interesting part about these two genera is that

their present distribution well bears out their great age—*Rhododendron* having reached as far as Queensland before Australia was separated, and *Garrulax* having penetrated as far as Borneo. The reason why the plant has gone farther than the bird is of course due to the fact that flowering plants first appeared in Mesozoic times, whilst the modern form of bird did not appear until Tertiary times, or after Australia became a separate continent.

Now let us turn to the Tibetan subregion, and I include in this region only the Tibetan Plateau, not the whole of Political Tibet. Blanford was the first to recognize the importance of this sub-region, claiming that among mammals it had 5 genera and 24 species peculiar to it. On looking into the avian population, we find there are 15 species and 12 subspecies peculiar to the Tibetan Plateau. In plant and insect life we also find that many forms are peculiar. Such a profusion of generic and specific types is unparalleled in any other continental area throughout the world, and can only be compared with conditions so familiar to island fauna and flora. In islands, especially oceanic islands, we are accustomed to find relic forms which have continued to exist long after their continental relations have been engulfed or swamped by the competition of more vigorous types, and we may safely apply the same principles of distribution to Tibet as we would to either Madagascar or New Zealand. Its many peculiar forms have taken refuge on that inhospitable plateau whither their competitors have not been able to venture. Tibet is, in short, a huge alpine island, its fauna and flora originating and existing under precisely the same principles as govern the distribution and origin of life in the Arctic or any alpine region in the world.

Scharff rightly refers to Tibet as an island-like retreat of peculiar and delicate forms, and in this connection it is significant that on islands and peninsulas, Arctic forms exist in more southerly latitudes than they do on continents, for the reason that competition is less keen. We have the reindeer living in Caithness not so very long ago, the Arctic Hare occurs in Kamchatka, Scotland, and even Ireland.

With regard to other forms of life on the Tibetan Plateau, I shall confine my remarks to the distribution of two mammals and two birds which well illustrate the general principles of origin of life.

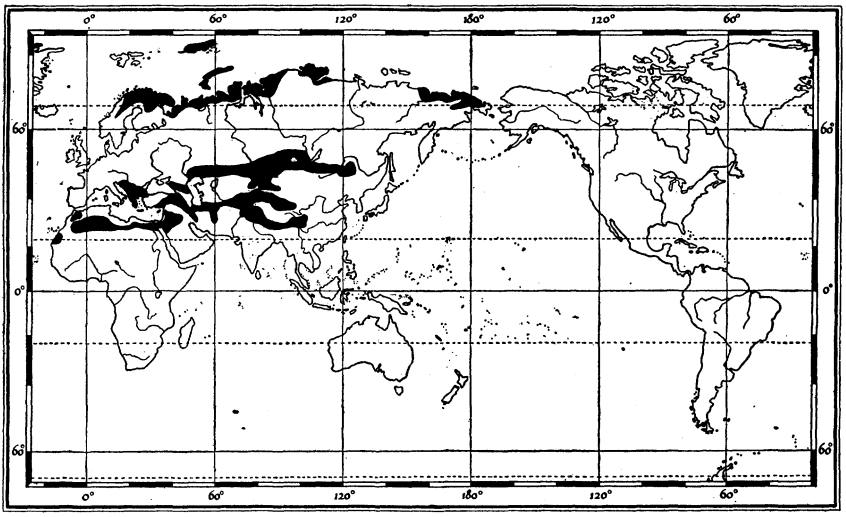
We must revert to the wild ass (*Equus hemionus*). It exists in six different forms in practically every part of Asia which is desert. One form (*kiang*) occurs on the Tibetan Plateau from Eastern Ladakh to Lhasa. Another (*hemionus*) occurs in the Altai region. A third (*indicus*) occurs in Kach and Baluchistan, a fourth (*castaneus*) round Kobdo in Western Mongolia, a fifth (*hemippus*) in 'Iraq, Syria and South-West Persia, and a sixth (*onager*) in North-West Persia and in the deserts round Tehran. The species formerly extended throughout Europe, where it is found to-day as one of the commonest fossils. The significance

of this distribution is that the species has been driven by competition into the most desolate parts of the world. What particular form of competition exterminated the wild ass in Europe is mere conjecture. But it has gone from every pleasant part of the Northern Hemisphere, condemned to live in deserts whether at sea-level or at 15,000 feet. Its status in Tibet is that of a refugee of probably northern origin.

The second mammal whose distribution is important for our purpose is the Arctic Hare (*Lepus timidus*). Its normal continuous distribution is circumpolar in regions where it has no apparent competition. All its southern colonies are relics of a once continuous distribution and exist only where it does not have competition. In Scotland it has been driven to the hills almost certainly by the Brown Hare. In Ireland, where the Brown Hare is not, it exists at sea-level. It again occurs in the Alps at elevations where the Brown Hare does not occur. Another race (*altiacus*) occurs in the Altai, and another (*oiostolos*) on the Tibetan Plateau. In Eastern Asia we find isolated colonies on Yezo, the north island of Japan, in Kamchatka, and the Khingan Mountains of Manchuria. In America there is a race (*bangsi*) in Newfoundland. This distribution displays much the same characters as that of the wild ass. The Arctic Hare cannot live with competition, and is compelled to exist in those parts of the world where it does not have to compete. In confirmation of this it may be noted that it formerly existed in Southern England, whence it has been driven by the new arrival—the Brown Hare. It is also found in fossil form in Italy. In Newfoundland, where the American Hare has been recently introduced, it has become rare and now only occurs in the bleakest parts, driven there by competition. Its status in Tibet is also that of a refugee.

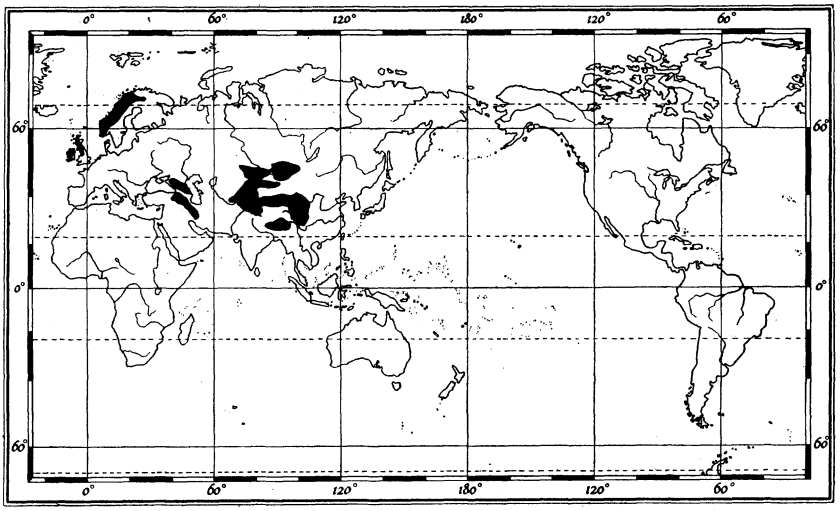
To turn now to birds. There is no case of a true Himalayan species occurring on the Tibetan Plateau, except one or two instances of cosmopolitan forms. Bird-life on the plateau can be placed in two categories. In the first place, those species which occur in most of the elevated parts of Asia and nowhere at low levels, and secondly, those species which exist in desert-like regions without regard to latitude or altitude. In the first category we have the snow-cocks (*Tetraogallus*), some of the Accentors and snow-finches (*Montifringilla*), and the Alpine Chough. In the second category, which embraces the majority of Tibetan birds, we have some remarkable examples of continuous distribution. The Tibetan Raven occurs in one unbroken distribution from latitude 80° in Greenland to Ladakh. The Horned Lark (*Eremophila*) is circumpolar with numerous forms spread out throughout the desert or mountainous portions of Europe, Asia, and North Africa, whilst in America an isolated colony occurs in the Andes of Colombia. A competitive force works against it in the Old World and compels it to live in deserts or at altitudes where other life has difficulty in living. It is undoubtedly a bird of northern origin and a refugee from more congenial climes. Some other

form of lark is probably its competitor in the Old World and has driven it out from pleasanter surroundings. The Twite is another example whose competitor is probably the closely allied Linnet. It occurs



Distribution of Eremophila Alpestris (Horned Lark), European and Asiatic

throughout the mountain ranges of Central Asia and in the Caucasus, turning up again in an isolated colony in Scandinavia and the British



Distribution of Acanthis Flavirostris (Twite)

Isles. Elsewhere it cannot compete. So here is yet another refugee of undoubted northern origin. Other birds give similar results if their distribution is mapped out.

What then is the origin of life on the Tibetan Plateau? We can safely say that Tibetan life comprises those branches which have failed to stand against competition and have taken refuge either on high mountain tops or in deserts, and Tibet satisfies both these conditions.

Before examining the Kashmir sub-region let me briefly refer to an interesting zone running along the north edge of the Himalayas and above timber-line. The Tibetan sub-region is part of the Palæarctic Region, and the afforested area of the Himalayas is true Oriental, though recently its higher levels have been (erroneously) regarded as Palæarctic. Between these two major regions runs a narrow strip of grassland at great elevation, sometimes but a mile or so across, sometimes up to 50 miles in extent, and sometimes in island-like patches. This narrow zone has some peculiar forms, some of which have come in from the north, though the majority have come in from the east and the south. It is a true contact zone between the Oriental and Palæarctic Regions. Among birds, such forms as *Lerwa*, *Grandala*, *Columba leuconota*, *Pyrrhospiza*, and others are characteristic.

Lastly we come to the Kashmir sub-region, in which is included Kashmir north of the Pir Panjal, Baltistan, Western Ladakh, Gilgit, Astor, and Chitral. Among mammals we find no representative of any exclusive Oriental genus, whilst certain typical Oriental forms, such as the Sambhar Deer, are lacking, though common in the central Himalayas. But, generally speaking, in nearly every genus which contains members inhabiting the Himalayas and Peninsular India, one of the species occurs in Kashmir. Perhaps the most remarkable mammal in Kashmir is the Kashmir Stag (*Cervus cashmirianus*), a relic colony of northern origin, and nearly related to our Red Deer.

Among birds we find some purely Palæarctic forms in Kashmir which breed nowhere else within British India, and of this group the Jackdaw is a good example. Then again we find certain forms such as the Kashmir Starling (*humii*), a Bluethroat, the Carrion Crow, the European Roller, and others which breed nowhere else within British India than in Kashmir. But perhaps the most instructive bird is the form of European Nuthatch (*cashmirensis*), which occurs nowhere else but in Kashmir. This form more closely resembles its European relatives than the other forms of the same species which occur elsewhere in the Himalayas or in Peninsular India, and was probably derived from the north or west, whereas Himalayan and Peninsular Indian forms were derived from the east.

What we find among birds and mammals we also find among insects and plants—a curious medley of eastern and northern forms. In many cases the movement of life from China along the Himalayas has not yet reached Kashmir.

When in Western Ladakh 19 species of butterfly were collected, which can be considered representative of butterfly life in that region, and of

these only one species extends into Peninsular India and only four extend east along the Himalayas. The remainder are all forms which occur commonly in Turkistan and Western Asia, and of nine species of moth collected in the same locality, not one extends either east or south of Kashmir.

Of 88 species of flowering plants collected and which can be considered representative of plant-life in Western Ladakh, 16 belong to genera which also occur in the Arctic, and 7 species occur in identical form in the Arctic.

Speaking generally, we can say that animal and plant life in Kashmir shows greater affinity to the Palæarctic than to the Oriental Region, and that certain exclusively Palæarctic forms have become isolated there, indicating a former continuous distribution. Oriental forms of life are probably of recent arrival in Kashmir, which is confirmed by such forms becoming fewer and fewer as we approach Kashmir along the Himalayas from the east.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: To-night we are to listen to Col. Meinertzhagen. To those who have read the *Journal* the name is not new; but I believe he has not previously addressed an evening meeting of this Society. To me his name is very familiar indeed. He was famous in the war for combining the pursuit of natural history, and particularly that of ornithology, with gaining accurate information of the enemy and even with provoking him! He is one of those travellers who is able to people deserts and waste spaces with living creatures, and his geographical interest is not greater than his zoological and ornithological. I always think that those who combine those interests are able to give us the most interesting papers. Therefore, with the utmost confidence, I ask Col. Meinertzhagen to deliver his address.

Col. Meinertzhagen then read the paper printed above, and a discussion followed.

The PRESIDENT: I think no one can speak to you more appropriately on the zoological side than Lord Rothschild, and I will call upon him now.

Lord ROTHSCHILD: When the President asked me to say a few words on the subject of animal and plant life in connection with Col. Meinertzhagen's lecture, I rather light-heartedly consented, thinking I should only have to say something from a purely zoological or botanical point of view. I was very much startled on getting Col. Meinertzhagen's paper to find that to say adequately anything about the most interesting address to which you have just listened would take me over the whole area of the origin of species from the Eocene period and also very far into what has proved a very thorny subject, namely, passive and aggressive mimicry. This is neither the place nor have we time to do any such thing. I will merely draw your attention to certain facts which must be taken into consideration when we think over what Col. Meinertzhagen has told us. I do not wish in any way to counter any of the conclusions that he has come to, but there are certain disturbing elements in the phenomena of animal and plant distribution in connection with Kashmir and Ladakh which must make us pause before we can realize exactly what Col. Meinertzhagen wanted to convey.

In the first place, I would mention in connection with his comment on Major Hingston's paper, about the so-called environmental mimicry, that I have found this very conspicuous in the North African desert with various species of rodents and also with the two sorts of crested larks. But I should like to draw attention to the fact that what Col. Meinertzhagen called species not in need of protection may also include such forms as have more recently come into the district and have not yet come under the stimuli which would bring about the protective coloration.

Again, I should like to say, on the question of the origin of the fauna and flora, that the two special groups that Col. Meinertzhagen has picked out, the *Garrulax*, or Laughing Thrushes, and the Rhododendrons, have certain features which also must make us consider very carefully their connection with the distribution of these forms. It is quite true that with both we find in certain regions round Yunnan and Szechwan that they have reached what I may call their zenith; that is to say, we find the largest number of species and races all crowded together there, but I am not quite sure whether it is absolutely necessary to consider that that is the central point from which these forms were distributed. For example, among the Rhododendrons you find three very distinct groups. There is the ordinary Rhododendron group consisting of numerous species and races allied to *R. arboreum*, with *R. Griffithianum* and *Dalhousiæ*, *R. Ponticum* in Europe round the Black Sea, and even in the Alps *R. ferrugineum*. Then you find the group which horticulturists call Azaleas, growing in some parts of India, in Japan, in many parts of North America, and even one little species, Rhododendron or *Azalea procumbens*, in the Alps and even, I believe, indigenous to Scotland. Lastly, you find a whole group of species with totally different habits and with quite differently shaped flowers, for they are tubular and more like the flowers of some of the creepers such as convolvulus, which form the *R. narcissiflorum* and *Javanicum* groups that reach their full development in the Malay Archipelago and extend to the Philippines, New Guinea, and Northern Australia.

Col. Meinertzhagen drew our special attention to the fact that there are rhododendrons in the Nilgiris. There is only one, *R. nilagiricum*, which is distinctly an *arboreum* rhododendron, and therefore directly connected with the Sikkim, Himalaya, and Yunnan species, but I am not at all sure that the azalea group, and especially the *Javanicum* group, have at all the same connection, nor whether they originated in the same areas as the *arboreum ferrugineum* group.

As to the thrushes, or *Garrulax*, I quite agree that the probability is that the family came directly from the East, but we are faced with a curious fact: that one species of *Garrulax*, a very conspicuous dark rufous-grey bird with snowy white head and neck, *Garrulax leucolophus*, extends in its typical form from Simla to the Himalayas and Sikkim, and to the most northern parts of Burma. That form in the northern parts of Burma has been recently separated as a local race, but I very much doubt if it is sufficiently distinct to merit separation. Then we find it again in quite a small corner of Yunnan round the settlement of Tengyueh and the Salween river, a very few miles from the border of Southern Burma and Siam. Less than 50 miles distant you find, in Southern Burma and Siam, two totally different races which, instead of having dark brown breasts, have more or less white breasts—*Leucolophus diardi* and *bellangeri*; and yet in this little corner of Yunnan, not 50 miles distant from where the white-breasted forms occur, you find the typical form, and do not find the white-breasted *Garrulax* anyhere else in Yunnan. I

believe, therefore, that there is a double migration, one west and one east, and it is not at all certain that, where these forms have reached their greatest abundance, they have originated and that they have spread from there. I think they may have had a different place of origin, and that in those districts where we find them most plentiful to-day they may have found some conditions which have enabled them to increase more largely than in other parts. But I do not think that we can, taking those points into consideration, doubt the general correctness of what Col. Meinertzhagen has said, namely, that a very large proportion of the fauna of Kashmir and Ladakh had an eastern origin.

The PRESIDENT: Major Hingston has been challenged to-night; perhaps he would like to get in his blow.

Major R. W. G. HINGSTON: I have, no doubt, been asked to join in this discussion because Col. Meinertzhagen has devoted a considerable portion of his lecture to a criticism of observations made by me while serving on the last Mount Everest Expedition. He brings forward two of my papers. The first deals with the effects of high altitude on the human body. With that paper Col. Meinertzhagen seems to agree; at least, he has repeated the various observations contained it it, and has found himself in substantial agreement with them. It is the second paper, one dealing with animal life at high altitudes, that he seems to disagree with entirely. He has prefaced his criticisms by some very kind remarks, and has then made quite a serious attack. Perhaps I may be allowed to adopt the same procedure.

It is a great pleasure to say kind and flattering things about Col. Meinertzhagen's excellent lecture. It is really a genuine delight to find a traveller coming back from the waste places of the Earth and telling us all kinds of interesting things about the beauties and the wonders of Nature, quite apart from the ordinary incidents of the journey. Col. Meinertzhagen has clearly kept his eyes wide open, for he has seen all kinds of interesting things and told us all about them. His paper deserves the highest praise. I can only assure him that I shall read it and re-read it, and always, I am certain, with instruction and delight. So much for the compliments.

I now pass to the lecturer's criticisms. Col. Meinertzhagen began by criticizing my definitions. Now it is a very good thing when starting a line of criticism to commence with a definition; but it is a very bad thing to be inaccurate in your definition, for the definition is, so to speak, the foundation stone, and if the foundation stone is faulty the superstructure is not likely to be sound. I am afraid Col. Meinertzhagen has chosen the faulty course. He begins by saying that Major Hingston defines Tibet as "essentially a desert." That is a very simple definition, but the lecturer apparently does not agree with it. He wants to improve it. He wants to elaborate it. He therefore says that he would define Tibet as "a high-altitude desert." Now I certainly will not quarrel with him on that little point, but his improvement is really quite unnecessary, because if he will turn again to that paper which he so pungently criticizes he will find that at the very commencement of it, in fact in the sixth line of it, I myself have defined Tibet as "a high-altitude mountainous desert at an elevation of about 14,000 feet." Having thus exposed the fault in the foundation, let us proceed to examine the superstructure.

The next point that comes up for criticism is in respect to some remarks that I made on the subject of protective coloration. I wrote in my paper that many of the animals which lived at high altitudes on the Tibetan plateau were protectively coloured in order to resemble the plateau soil. I quoted birds, mammals, insects, and reptiles amongst the examples. Col. Meinertzhagen

seems in some way to object to that statement. I do not quite understand if he objects to it *in toto*, or if he is just administering a series of pin-pricks. One thing, at any rate, he clearly objects to, and that is my expression "protective coloration." He thinks it ought to be changed into something simpler, and he applies the term "Environmental Mimicry." Now, why in the world does he want to change an expression which everybody understands into another expression which nobody understands? He wants to change it, he says, because protective coloration implies a purpose. And why should it not imply a purpose? If there is anything which is clear in the whole realm of Nature it is that the purpose of protective coloration is to protect. We see examples of it all over the world. We see desert animals coloured sandy in order to blend with the sand; Arctic animals coloured white for the purpose of blending with the snow and ice; insects living in the trees in great numbers coloured green for the purpose of blending with the green leaves; insects inhabiting the trunks of trees in many cases mottled in order to blend with the bark; leaf insects, stick insects, and flower insects all coloured in particular ways in order to blend with their particular haunts. Now, if there is anything at all in all this, it is that these creatures are coloured in these particular ways for the purpose of being protected in their particular haunts. But Col. Meinertzhagen does not seem to agree with that. He says there are exceptions. Of course there are exceptions. There are exceptions, or at least apparent exceptions, to every biological principle of that kind. Any naturalist could produce hundreds of them. Col. Meinertzhagen himself has produced exceptions. But the interesting thing about Col. Meinertzhagen's exceptions is that they are really not exceptions at all. Let me give an example. He says that there are certain rodents which live in low-lying deserts, and that those rodents blend with the sand, yet they come out only at night. Therefore it is, in his opinion, quite unnecessary that they should be protectively coloured, since they come out only at night. But are there not nocturnal enemies just as well as diurnal enemies? Do not wild cats, foxes, wolves, owls, and Heaven knows what not, prowl about by night in search of prey, and may it not be just as necessary for night-haunting creatures to be protectively coloured against nocturnal enemies as for day-haunting creatures to be protected against diurnal enemies?

Col. Meinertzhagen passes on to consider the causation of protective coloration. He thinks that rainfall may have something to do with it. And then he goes on to say that there may be some influence, some kind of emanation, I suppose, coming out of the rock or soil which has the effect of changing the colours of the animals and making them look like the soil. I do not think we are likely to get much further by following a theory of that kind. We should have to look for emanations in all kinds of curious places, one kind of influence coming out of the sand and making creatures like the sand; another out of the snow making creatures white like the snow; another coming out of the leaves making certain insects green so as to blend with the leaves and not having any effect on other insects, and so on. Yet we can get quite a sufficient explanation from the old masters of natural history. Darwin and Wallace clearly taught us that natural selection was sufficient: that those creatures which best assimilated with their surroundings survived, and those which did not assimilate so well were weeded out in the great struggle for life, and that this process of weeding and improvement coming down the centuries has produced that remarkable assimilation, in some cases that perfect camouflage, which exists in the world to-day. It is remarkable how attempts are made

again and again to alter or to put aside or to modify those great Darwinian principles, and equally remarkable how those great Darwinian principles always come back into their own once more.

I pass to the next point. I stated in my paper that certain mammals which live at high altitudes react to the strong winds which blow at those altitudes by growing thick coats of hair. I quoted yaks, pigs, and goats as obvious examples. Now Col. Meinertzhagen seems to object to that statement. According to him it is incorrect to say that these animals react to the cold winds at high altitudes by growing thick coats of hair, because there are mammals in other parts of the world at low altitudes—I think he said in Japan and Kamchatka—which also grow thick coats of hair when exposed to cold winds. I am afraid I cannot follow the lecturer's reasoning. If any one came to me to ask for advice about going to high altitudes, I would say that one of the special requirements of high altitudes is to wear plenty of thick clothes. I do not suppose that my questioner would disagree with me. But Col. Meinertzhagen would completely disagree. He would say, "You must not make such a statement. You must not say that it is a special requirement of high altitudes to wear thick clothes, because, you know, many people have to wear very thick clothes on a cold March day in London."

I come to another point. I stated in my paper that there are certain birds which live at high altitudes which have particularly long, strong beaks, and that such beaks are very well suited for boring into the frozen soil at those altitudes. I quoted the chough, the ground chough, and the Calandra lark as examples. Col. Meinertzhagen makes no objection to the ground chough and Calandra lark, but seriously objects to my including the common chough. He says, "You must not say that the common chough has a particularly strong bill adapted to boring into the frozen soil of Tibet, because the chough exists in Cornwall where the ground is very seldom frozen, and therefore the strong beak cannot be adapted for digging into frozen soil." In other words, his argument runs thus: that because a certain implement is not necessary for a certain purpose in England, therefore it cannot be useful for that purpose somewhere else. In this connection Col. Meinertzhagen drags in geology to his assistance. He says that the chough has lived for a long period of time in its present state; in fact, before the Tibetan plateau came into existence. That, of course, is a kind of final deathblow; because if the chough did exist before the Tibetan plateau came into being, then of course its bill could never have been intended for boring into the frozen soil of that plateau. But geology may prove to be a double-edged weapon, for if the chough did exist for that immense period of time before the Tibetan plateau came into existence, then it must have existed during those long periods when the greater part of Europe and the whole of the British Isles was under ice-sheets and when the ground was frozen hard. And for all Col. Meinertzhagen may know to the contrary, and certainly for all I know to the contrary, the chough may have actually been enabled to survive and may have been preserved by reason of the very fact that it possessed such a bill which was long enough and powerful enough to bore into the frozen soil of England.

I come to the next point. I stated in this paper which has been so pungently criticized that there is a short-toed lark at high altitudes in Tibet which possesses the interesting habit of building a rampart of pebbles round its nest. I said it did so in order to prevent the high-altitude winds of Tibet from blowing sand into its nest. Col. Meinertzhagen seems to object to that. He says, "You must not say that it builds a rampart of pebbles in order to protect itself from

high-altitude winds, because there is a lark in Mesopotamia which also builds a rampart of pebbles, another in Palestine which builds a similar rampart, and still another in Algeria which also builds a rampart, and they all do it for the same purpose; therefore you must not say that the lark which lives in Tibet builds a rampart of pebbles in order to protect itself from high-altitude winds."

I really think that he is making a mountain out of a molehill. Let me therefore give you, in conclusion, an exact parallel. Everybody knows that the people who live at high altitudes are very dirty. Everybody knows that the Tibetans never wash themselves and never change their clothes. Now, if I were to say, "It is a characteristic of the people who live at high altitudes to be very dirty," I do not suppose that any one in the audience would seriously disagree with me. But the lecturer would totally disagree. He would say, "You must not say that it is a characteristic of the people who live at high altitudes to be very dirty, because, you know, there are people in the slums of London who are very dirty, and because the Eskimo who inhabit Greenland are remarkably dirty, and because the inhabitants of Tierra del Fuego are notoriously dirty; therefore you must not say it is a characteristic of the people who live at high altitudes to be very dirty." And that, so far as I can see, sums up the whole of the lecturer's argument, and that is my simple refutation of it.

Mr. F. KINGDON WARD: After the delightful lecture that we have listened to this evening it seems a little ungracious to take up the position of opposition, and after the extremely interesting and amusing speech we have just heard I am afraid mine will seem a bathos. But there is one point which I should like to criticize, the question of discontinuous distribution, particularly with regard to Rhododendrons. It seems to me that discontinuous distribution does not necessarily mean previously continuous distribution; it may have been successive distribution. The lecturer quoted the example of *R. arboreum* or *Nilgiriense* found in Southern India, which is practically the same as *R. arboreum* of Sikkim; and through the whole length of India this plant does not occur. If we suppose that the plant has been pushed southwards by ice it is perfectly easy to conceive that it gradually took up different positions on its journey southwards, and eventually landed up in the Nilgiris. The country got warmer and warmer; the rhododendron simply stayed in the south; it never covered the whole land at all, and when the country got warmer there was one *R. arboreum* in the extreme south of India and another in Sikkim. Take a very simple illustration of the same effect. This country exports prize cattle to the Argentine. That is the same thing being done on a very much more rapid scale. The ice, or the cold we will say, creeping southwards gradually exported *R. arboreum* into the south of India. There is no continuous distribution of prize cattle between here and the Argentine. They simply have been moved from one place to the other.

The other point is the question of distribution of the flora through China westwards through Sikkim, Bhutan, and Kashmir. I do not question the lecturer's conclusion that the flora moved from the east to the west, but I do question his evidence for it. It may have been so, but I am far from convinced on the evidence I have heard to-night, because it is perfectly easy to conceive the flora starting in Kashmir, Sikkim, or Bhutan, and gradually moving eastwards. We will suppose there are quite a few species to start with, but they come into this wonderful country of Upper Burma and South-Eastern Tibet and decide to settle down, increase, and multiply. They proceed to do so, but it is no proof that because you get fewer species in the east than the west the flora must have moved from the more prolific to the less prolific country.

Dr. HEBER: I suppose, like most medical men who have lived at altitudes, I also have fallen into the temptation of trying to find out the effects of altitude on the human body. When I did so I too had had the pleasure of reading the paper by Major Hingston. I have come to the conclusion that I must be very careful what I say about Major Hingston! Col. Meinertzhagen has referred to the fact that at certain altitudes he felt more uncomfortable and at higher ones more comfortable. I think that is quite a common experience. I remember well going up the Kardong pass behind Leh for the first time. I got to about 14,000 feet and felt anything but well. I had a bad headache and all the symptoms of mountain sickness, and wondered how I was to get on at the top of the pass. But the higher I got the better I felt. In 1913 we had the Anglo-Italian Expedition in Ladakh with us, and Sir Filippo de Filippi, the then leader, told me that he felt worried about his second-in-command because he was feeling the altitude even in Leh, which is only about 11,000 feet, and they were going up to the Depsang plateau, which is nearer 20,000 feet. The Ladakhis feel unwell on certain passes and on others they are quite comfortable, and they say it is due to a certain plant which grows on the passes where they do not feel so well. I personally have never found the plant, but an Englishman sent me one which had a very pungent smell and would certainly be able to cause mountain sickness.

Then Major Hingston in his paper refers to the blood count. I also did a blood count in Leh, because it is chiefly through the blood that the altitude affects the body. My findings were not quite his, and I think the differences are interesting. I am speaking without book, but as far as I remember Major Hingston took his material up with him. If I am wrong perhaps he will contradict me—no doubt he will! The people on whom I made my investigations were actually born in the country and had lived there all their lives. I found that, taking Asiatics, they on the whole, had a higher blood count than we have here in England or at the lower levels, but their blood count was less than Major Hingston found with his material. What was most interesting to me was the fact that the Ladakhis as distinct from other Asiatics, and down-country Indians, had a still lower blood count than the Indians. The Ladakhis, as a matter of fact, were very little above the blood count for English, being about 5,800,000 red cells per cubic millimetre. It seems therefore as though the blood of the Ladakhi had learnt to do its work of carrying oxygen better, and therefore it was not quite so necessary to have such a great number of cells.

Col. Meinertzhagen has also referred to the fact that he found an increased respiration and pulse-rate. Again I investigated about 200 Ladakhis, and I found with them, too, there was an increase in both these things; but what to me was most interesting was that in the case of English people the lung capacity itself increased and the chest enlarged. My wife found that after two years' residence in Ladakh her chest measured 2 inches more than it did when she went up there. Some years ago I walked up from Srinagar, the capital of Kashmir, with a friend. Before leaving Srinagar I took measurements of her chest, and I found when I got to Ladakh these had increased by half a centimetre. You may object that that was accidental, that perhaps I had not held my measuring tape as firmly as I did in Srinagar. But when I took her measurements a second time I did not know what her first were; I had quite forgotten them. At any rate, I think it is established that residence at high altitudes does increase the lung capacity.

Another interesting point was that the right heart increased in size. I think you will see that this is quite a useful thing because it is the right side of

the heart which pumps the blood to the lungs, and you want more blood there. On the other hand, I found the blood pressure was rather lower, and that too is very useful. The left side of the heart has a good deal of strain at high altitudes. Therefore with a lower blood pressure it has less hard work to do.

May I refer to the Mystery Play at Hemis, which to me is still a mystery? We have tried unsuccessfully to connect the separate incidents of the performance into a consecutive plot, but this seems almost impossible. We have endeavoured to find out its meaning from priest and layman, but received as many explanations as we had informants. I cannot help thinking that the play as it exists to-day is a result of evolution, various scenes having been added at various times. Col. Meinertzhagen is quite correct in surmizing that on the whole it is to teach the layman what happens to the soul after death. The explanation often given by the Ladakhi is that we have to meet hideous demons when the soul leaves the body, and therefore it is wise to get used to the look of them in this life. There is also very definite teaching of vicarious suffering. The effigy which is cut up was, no doubt, a human sacrifice in former times. But, above all, the Devil Dance seeks to make clear to the layman that in order to obtain salvation the priest is absolutely essential. It is only the lama who can save the soul that is beset by perils after death, and thus the play brings grist to the monastic mill.

The PRESIDENT: I believe Mr. Wollaston would rather not speak, and as the hour is getting late, I will ask Col. Meinertzhagen if he would like to reply to Major Hingston or to anybody else. I find he would rather not say anything. Well, you must have had an amusing and even exciting evening, and realized what vitality there is in scientific circles. Quite seriously, I think we owe a great debt of gratitude to Col. Meinertzhagen for having poured out before us the result of his own acute curiosity and acute observation. It certainly, as I think Major Hingston said, is a great thing to find some one with the unique and singular qualifications that Col. Meinertzhagen possesses to devote his interest to the various features of a country so little known as the country above Ladakh. We have seldom had, I think, a paper in which so many different features of life, both human and animal, have been conjoined with a description of scenery. I ask you therefore to signify your gratitude to Col. Meinertzhagen in the ordinary way.

ATLASES OF THE BRITISH ISLES

The Printed Maps in the Atlases of Great Britain and Ireland. A Bibliography by **Thomas Chubb**. London: The Homeland Association. 1927. 13½ × 9, pp. 479. *Facsimiles.* £2 10*s. net.*

STUDENTS of British cartography owe a debt of gratitude to Mr. Chubb for the labour and research he has put into this monumental work, on the preparation of which he has been engaged for many years. In spite of the restriction of the field to maps in atlases or similar collections (those issued separately being left on one side), the undertaking was a gigantic one, and we can only admire the industry and perseverance which has brought it to completion with little or no assistance to the author beyond that of his colleagues in the British Museum Map Room. The task could hardly have been so successfully accomplished by any one lacking Mr. Chubb's advantage of constant access to the unrivalled collections housed in that department of the Museum,