

TIBET AS A GRAZING LAND

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THERE IS AN aspect of Tibet, and in the modern world perhaps the most important one, which is rarely emphasized. The people with their strange culture and stranger religion, the topographical features, violent and primitive like those of newly upheaved crust, the fierce climate, the vegetation—where there is any—have all been the theme of travel books or have received attention in geographical literature. But Tibet considered primarily as a grazing land seems to have been overlooked. Yet that is what it really is.

My object here is to make a contribution to the geography of Tibet from this aspect, partly as a result of my own observations, and at the same time to indicate briefly how incomplete and indeed one-sided our knowledge of the country is. I hope also to suggest the lines along which, in my opinion, research might profitably be carried on for the benefit both of the inhabitants and of the world generally.

Tibet has no clearly defined political frontiers recognized by the Tibetans themselves and by their neighbours; still less has it clearly defined geographical boundaries. Hence the name Tibet is in a sense a geographical expression, an abstraction; it is a regional rather than a political name. Here the term Tibet is used in its most comprehensive sense, unrestricted by political prejudices, having regard only to what constitutes the Tibetan plateau lands.

By far the greater part of the country is divided between desert and grazing land. Forest and arable land form a very small proportion of the non-desert area. Before describing the pasture land in detail, it will be helpful to give a brief sketch of the topography of Tibet as a whole and its probable evolution.

Fundamentally, Tibet comprises a huge plateau which, having been subjected for many millions of years to climatic wear and tear, has lost some of its simple outlines and in parts has taken on an unplateau-like appearance. In short, raw as it appears at first sight and far from mature as it undoubtedly is, Tibet has lost its first youth.

From the beginning the plateau was no doubt crossed by ranges of mountains, as it still is, rising several thousand feet above the general level. These ranges are separated from one another by trough-like valleys of varying but always considerable width. In fact, the troughs constitute the most obvious part of the plateau on which the elevated portions appear as mere excrescences. Scores of lakes, large and small, break the smooth monotony of these plateau troughs. In the west the ranges appear to originate in the knot or node of the Pamir plateau and, after diverging slightly, to keep roughly parallel for 1000 miles before making their exit in the east. Here and there however a range bifurcates, so that more ranges appear to leave the plateau in the east than enter it in the west.

The whole of northern, western, and central Tibet, and of southern Tibet

west of Lhasa is plateau-like to the eye. Even a traveller crossing the country from north to south would confirm this, for he would more often be crossing wide stony plains than climbing mountains. Still more would he confirm it were he to travel eastwards along one of the wide troughs between the ranges, for the mountains would be far away most of the time.

What is more difficult to realize is that south-eastern Tibet is part of the same plateau; for there is probably no part of the world which looks less like a plateau, consisting as it does of a network of high, narrow mountain ranges separated by profound gorges. No one looking westwards from Yachow, eastwards from Sadiya, northwards from Fort Hertz, or southwards from Taochow would be likely to think of the view before him in terms of a plateau. Yet the gigantic and intricate mountain ranges of south-eastern Tibet have actually been worn from the outer rim of the plateau and must be regarded as part of it. They are not, as one might think, due to special uplift apart from the rest of the plateau and at a different geological period. On the contrary, they appear to be of the same age and to owe their elevation to the same forces acting throughout the same period. Although the geological structure of the region is unknown—and the geologists will no doubt claim the last word—a geographer's view of it and of the superficial forces now at work can lead to no other conclusion. This view is further supported by botanical and zoological evidence, though this is far from complete.

In order to understand the evolution of Tibetan scenery, it is essential to examine the whole region here called Tibet, from the plains of India and China, across the Himalayas and the snow mountains of Yünnan and Szechwan, to the heart of dry Tibet, and to note the forces at work on it now and in the past. The geographer then will recognize six natural sub-regions, four of which show clearly enough their origin from a typical plateau. The other two are not perhaps sub-regions at all, but local variations or sub-sub-regions. However, it is convenient at present to regard them as equivalent with the four major sub-regions. The six sub-regions are as follows: (1) the interior plateau (Tibet of the nineteenth-century travel books); (2) the outer plateau (Tibet of the Younghusband Mission to Lhasa); (3) the rainy gorge sub-region (the Tsangpo gorge); (4) the arid gorge sub-region (Tibet of Huc and Gabet); (5) Tsaidam (Central Asian Tibet); (6) Chinese Tibet (western Szechwan and Kansu, north-western Yünnan).

The interior plateau or Tibet lake basin (Tibetan: chang tang)

This is the last remnant of the original plateau after long continued weathering and attendant forces have worn away the rim on three sides. The lake basin consists mainly of flat, gravel-covered surfaces with lacustrine beds derived from dried-up lakes. There are also wind-borne accumulations and others perhaps settled from sheet glaciers. Wide stony plains stretch east and west between comparatively low rocky ranges. Although heavy rain falls for short periods during the summer,¹ the rainfall appears to be dwindling. There are very many salt or brackish lakes, their longer axes lying east-west, parallel with the trough valleys. The mountain ranges do not rise much above the general level of the plateau (16,000 feet) and have sierra-like crests. Glaciers

¹ Sven Hedin, 'Central Asia and Tibet,' vol. 2, pp. 318-9, 325-6. London, 1903.

are few and small and of the hanging type. Weathering is in excess of transport, which is confined to wind and to rivers which are in spate for short periods only and dry for most of the year. All drainage is internal.

Owing to drought and to the severe climate, the interior plateau is a near-desert. Temperatures, even in summer, rise only a degree or two above freezing, but the daily and seasonal temperature range is much less than it is in many parts of the world. Temperature gradients also are low. Vegetation is extremely scanty; the fifty or sixty species of flowering plants known are widely scattered and all are dwarf or stunted forms. Only two or three species are endemic. A very few woody plants send up annual shoots from stout perennial root-stocks. Grazing appears to be of the scantiest. Nevertheless large herds of antelope are reported by Deasy¹ in the north-west. Their visits may possibly be seasonal.

For the present at least the interior plateau may be dismissed as comparatively useless to man, except perhaps as a landing ground for aircraft and on some of its lakes for flying-boats. Certain arctic plants, *e.g.* "reindeer moss," might perhaps be introduced in some parts. Conversely, it is possible that a few plants which grow here, *e.g.* Ephedra, might profitably be grown in similar regions elsewhere.

There is every reason to believe that the whole of the outer plateau and river gorge region was originally part of a single plateau or lake basin, though possibly there were two or more disconnected lake basins. To-day we can follow the gradual transition from interior plateau to outer plateau and from outer plateau to gorge country without much difficulty.

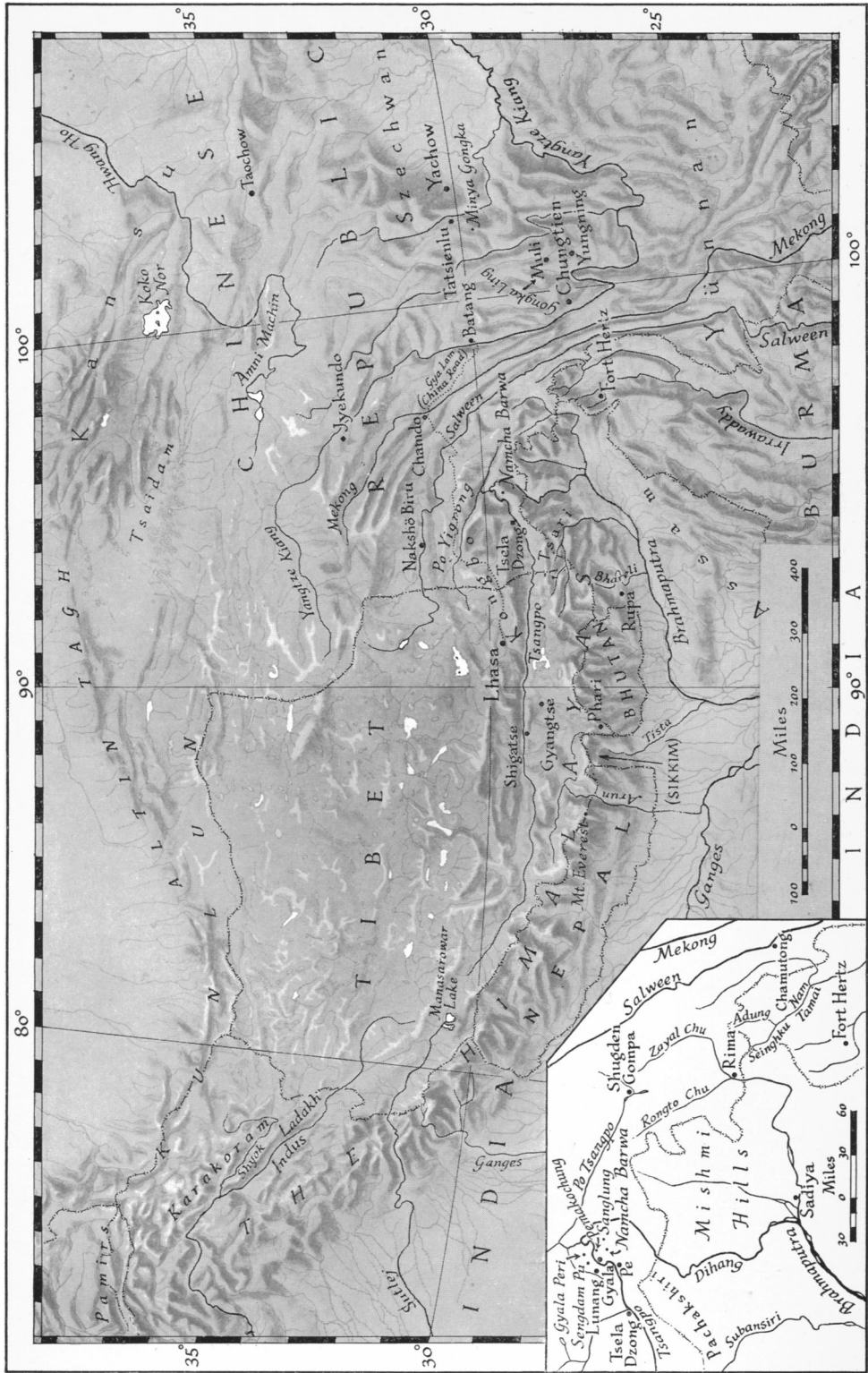
The outer plateau

Streams, rising on the outer slope of the lake basin, flow away from it and eventually reach the sea. At their heads they sap back into the rim of the basin, gradually capturing its rivers and draining its lakes. Owing to the uniform general altitude, there is no sharp distinction between the two regions and no appreciable watershed. In the south-east quadrant at least, the watershed is marked by marshy plains spread over enormous areas at the ultimate sources of the Hwang Ho, Yangtze, Mekong, and Salween rivers. The western margin of the lake basin is perhaps more easily defined, since the great mountain ranges of the western gorge country come much closer to the sources of the rivers than they do in the east. The dry climate seems to be an important factor here.

It is a point of some interest that the tributary rivers of the gorge region are cutting back into the outer plateau more rapidly than the main rivers can cut back into the lake basin. If this unequal erosion were to continue, the outer plateau would eventually disappear and the gorges abruptly succeed the lake basin, possibly with the formation of much greater waterfalls than exist at present. But other factors are likely to intervene before the process is complete. At present a considerable area of the outer plateau is indistinguishable from the interior lake basin, except by the presence of freshwater instead of salt lakes and perhaps a slight mitigation of climate.

In the south-east quadrant, the outer plateau slopes more rapidly towards

¹ H. H. P. Deasy, 'In Tibet and Chinese Turkistan,' p. 26. London, 1901.



habitable levels, due no doubt to the larger number of rivers. In the north-west the transition is abrupt; some parts of the outer plateau close to the rim of the lake basin are habitable, in spite of the fact that there is no cultivation; for example, in the neighbourhood of Manasarowar and in parts of Ladakh.

The outer plateau is the most valuable part of Tibet, as well as the part familiar to European travellers and the only part most of them ever see. Naturally therefore the gravel plains, such as those which stretch from Phari to Gyangtse, with their lovely blue, freshwater lakes have come to represent Tibet as a whole. Nor is this unreasonable since, of the four major sub-regions into which we have divided the country, the outer plateau is the largest. But as always the geographer must here be on his guard against a partial or over-simplified picture.

The outer plateau comprises the great plains, at an average elevation of 13,000–15,000 feet, with their mountain ranges, often snow-clad, rising as much as 6000 feet above the general level, and broad valleys between. The lakes of the outer plateau are neither so numerous nor on the whole so large as those of the interior plateau, though they include Koko Nor, the largest of all Tibetan lakes. All are freshwater, and they too show evidence of contraction in the form of raised beaches, *e.g.* those of Manasarowar lake. The climate, though severe, is less harsh than that of the interior plateau, with heavier rainfall, especially in the east. At the lower levels the summers are almost genial and several crops are cultivated, of which the chief is barley. At Shugden Gumpa barley ripens at over 13,000 feet.

The headwaters of seven large rivers—Indus, Sutlej, Brahmaputra, Salween, Mekong, Yangtze, and Hwang Ho—rise on the outer plateau. Some of the Himalayan rivers, such as the Arun and Tista, as also the main stream of the Irrawaddy, have cut their way back a short distance through the plateau rim. The outer plateau is well watered, although in winter much of it is frozen. Even the Salween, according to Ronald Kaulback,¹ is solidly frozen over at least as far east as Nakshö Biru, probably as far as 95° 30' E.

The vegetation, which is almost entirely of the alpine type, is scanty at the higher levels like that of the lake basin, but becomes more varied and abundant as habitable levels are approached, especially in the south-east. Here scrub appears, mixed with alpine pasture. In the villages where irrigation is essential there are even a few trees—elm, willow, and poplar. The beginning of true forest, always coniferous, marks the boundary between the outer plateau and the gorge country. Just as the lake basin passes gradually into the outer plateau in the east—though without a change of climate or vegetation—so the outer plateau passes gradually into the gorge country.

All the principal Tibetan towns—Lhasa, Gyangtse, Shigatse, Chamdo, Jyekundo—are situated on the outer plateau, where cultivation begins, though it is still predominantly a grazing country. Most of the settled population is located here.

The outer plateau is divisible into two contrasted parts: rolling grassland in the east on the borders of the gorge region where the rainfall is ample, and gravel plains in the south and south-west bordering the Himalayas where rainfall is deficient.

¹ Ronald Kaulback, 'Salween,' p. 168. London, 1938.

The river gorge region

The great gorges of Tibet have a double origin; as some of them clearly show, they were cut first by glaciers and later by rivers. As pointed out by the late Professor Gregory,¹ the Mekong is a valley within a valley; and in the valleys of the Tsangpo and of the Nam Tamai, one of the sources of the Irrawaddy, I have observed two levels—an upper glacier level where the valley floor stood in glacial times, and a much lower water level where the floor stands to-day. This is almost certainly true of all the Tibetan rivers, at least in the south-east quadrant. Some of these rivers are double also lengthwise. That is to say, they have been formed by the linking up of a river flowing down the outer slope of the boundary ranges with an interior river captured by rapid head erosion. This process still goes on. Thus the Tsangpo gorge was formed by the Dihang in Assam cutting its way back into the ice-worn Tsangpo valley and capturing its river. The same is true of the Subansiri and probably also of the Salween, the Mekong, and other eastern rivers.

Following the Tsangpo down from the outer plateau to the gorge, one notices an abrupt change of vegetation in the neighbourhood of Gyala, due to the sudden change of climate from dry to moist. I have observed the same swift change on the upper Subansiri and on the Salween, where it is remarkably abrupt, in lat. 28° N.

Gorges imply that the river has cut its way through a mountain range or high plateau. It rarely if ever happens that a river flows in a deep gorge parallel to a mountain axis for any distance. In the Assam Himalaya several rivers flow in trough-like valleys more or less parallel to the outer ranges before breaking through them to reach the plains; the Bhareli and its tributaries are a good example of this. But the distances are small and the gorges are no more than steep-sided valleys, or they are associated with a particular rock, as at Rupa, for instance, where limestone outcrops. When therefore one sees the 200-mile-long gorges on the Mekong and Salween, situated where those rivers are, like the Tsangpo, leaving the plateau and turning south, one inevitably suspects that they are *crossing* the axis of a mountain range. That the Himalayan axis is prolonged north-eastwards from the hairpin bend of the Tsangpo across south-eastern Tibet and so into China is disputed by geologists on the ground that the mountains of Szechwan and Yunnan, if not of south-eastern Tibet, are much older than those of the Himalayan uplifts. But the geographer, viewing the arrangement of the mountains and seeing the deep river gorges like huge slit trenches, is not easily convinced by theoretical considerations. Not only the geographer but also the botanist and the zoologist who have studied the distribution of life in this part of the world can, I believe, come to no other conclusion than that these rivers are cutting across the axis of a great mountain range, whatever its age. Alone amongst modern geologists, the late Professor Gregory² took this view though perhaps with reservations. The fact that superficially the ranges here appear

¹ J. W. and C. J. Gregory, *Geogr. J.* 61 (1923) 167-8, and 'To the Alps of Chinese Tibet,' pp. 69-70, 308-10, London, 1923.

² J. W. and C. J. Gregory, "The Alps of Chinese Tibet and their geographical relations," *Geogr. J.* 61 (1923) 153-79, and 'To the Alps of Chinese Tibet,' pp. 304-14.

to trend north-south instead of east-west has no bearing on the problem: parallel rivers crossing a plateau or mountain range must necessarily carve parallel ridges between them.

I have treated the river gorge sub-region as though it were two, a wet and a dry. Nevertheless both have the same origin and such differences as they show are entirely due to climate, which in turn is the result of local or regional topography. As however these climatic differences bring about differences fundamental to man who occupies the gorges, the geographer is perhaps justified in treating them separately.

The arid gorge region.—North-west of Manasarowar lake is a narrow belt of country between the Great Himalayan range and the Karakoram where the Indus, Shyok, Sutlej, and their tributaries flow in deep gorges comparable with those of the eastern rivers. There is this difference however; the country is very dry, like the interior lake basin, hence there is no forest. Cultivation in these dry gorges is confined to alluvial fans which can be easily irrigated, and here too are the only trees, chiefly willow, walnut, and poplar. The country is barren, rocky or stony, and sparsely populated. On the Karakoram range are many glaciers and small lakes.

In the east, the gorges of the Salween, Mekong, and Yangtze are also rather arid. Large alluvial fans, well terraced for cultivation and skilfully irrigated, support a considerable population. Many of the fans are situated at some height above the river ("hanging fans"). Trees, notably walnut and pear, give a park-like appearance, particularly beautiful in spring when the fruit trees are in blossom. Farther south however, the Salween and Mekong rivers flow through rainy gorges. The arid gorge region in eastern Tibet is less well known than is the corresponding region in western Tibet.

In southern Tibet the upper Subansiri region is arid. So abrupt is the change from dry to wet here that, looking down the valley, one can stand beneath a blue sky and see the cloud bank where the rainy gorge and the forested slopes begin, 2 or 3 miles distant. It is as though a solid barrier were holding back the rain; the barrier being in fact the dry (and possibly high pressure) atmosphere behind the Himalayan rain screen. On the Subansiri however, as on the Tsangpo, the transition is from dry plateau to rainy gorge; there is almost no dry gorge region.

The sudden change from cloud to sunshine, from wet conifer forest to dry thorn scrub, is of course familiar on passes over great mountain ranges such as the Himalaya which lie across the direction of the prevailing wind; here the obstacle to the rain is visible to the eye and immediately recognizable. It is less common in river valleys, and one seeks in vain for a material obstacle to account for so sudden a change. Again it seems to me that the obstacle must be the latitudinal range through which the river has cut its exit, and whose axis lies athwart the direction of the prevailing wind, though it is no longer easily recognizable.

The rainy gorge region.—Proceeding outwards from the Tibet lake basin via the outer plateau, we pass from the arid gorges to the rainy gorges or, as sometimes happens, direct from the outer plateau to the rainy gorges. As already pointed out, arid and rainy gorges may occur on the same river, the change taking place within a few miles. It is in the area between the "wet"

and "dry" gorge that we find the high peaks of the dissected transverse range. A sharp separation between wet and dry gorge occurs, so far as I know, only on the Salween; but an equally sharp separation between wet gorge and dry plateau occurs on the Tsangpo.

The rivers which, in preglacial times, flowed down the outer ramparts of the plateau in a region of heavy monsoon rainfall were strong enough to cut their way back by head erosion into the rim and capture the plateau rivers. This was especially true of the rivers of eastern India during and after the Pleistocene glaciation. The Tsangpo gorge, for example, is a quite recent ice- and water-worn valley. There are tremendous moraines on both banks of the river between Gyala and Pe, two villages near the entrance to the gorge, where the river flows beneath the snow peaks of Namcha Barwa and Sanglung to the south, and Sengdam Pu and Gyala Peri to the north, and the river has cut the high banks of moraine material into terraces. Conditions here were no doubt ideal for the formation of deep narrow gorges. But all the south-eastern rivers and their main tributaries up which the summer monsoon penetrates from the plains leave the plateau by gorges. For this reason the gorges are lined with forest as far as the rain can reach. The monsoon blows more strongly up the Tsangpo gorge from the head of the Assam valley than it does up the Mekong or Salween which are farther inland. But so steep is the gradient that by the time the rain is spent in the Tsangpo gorge we are already on the plateau, and the river above Pe flows in a comparatively wide, shallow, ice-worn trough. In contrast, by the time the summer monsoon has been wrung dry in passing up the Salween valley, only a degree or two farther south, it is still some distance from the plateau and the deepest, narrowest part of the Salween gorge is arid. The gorges of the Mekong begin in about the same latitude ($28^{\circ} 30'$) and are still more arid; in fact rainfall decreases progressively in this belt of country as we travel northwards or north-westwards. Still farther north the Hwang Ho flows through partly wooded, partly arid, gorges as it flexes in wide bends from the outer plateau to the plains in the region of Amni Machin.

In the gorges of the Salween, Mekong, Yangtze, and Hwang Ho, owing to their great distance from the sea and from the plains, forest is confined to the higher slopes, at least in the arid gorges, and hence is mainly conifer. The Tsangpo gorge is filled with mixed forest, deciduous and conifer.

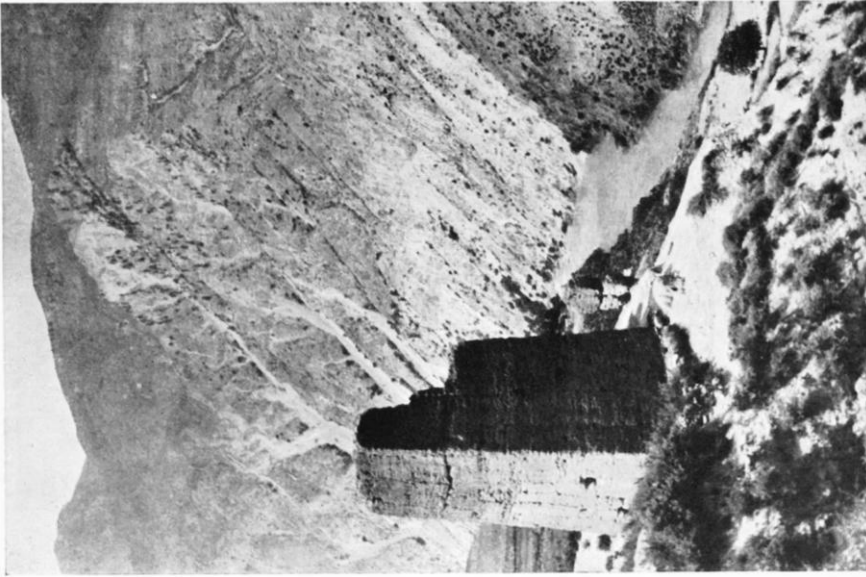
The gorge region bears no obvious resemblance to a plateau. Yet we can follow the gradual evolution of the Tibetan river gorges stage by stage from the plateau, and, as Gregory¹ clearly showed, the province of Yünnan is nothing more than a dissected plateau. The north Burma ranges beyond Fort Hertz also have been carved out of a plateau, as their profiles reveal. These three plateaus, the Yünnan plateau, the Irrawaddy plateau, and the much greater Tibet plateau, may all originally have been one; but their relationship has not yet been worked out. It would seem however that the Yünnan plateau is much older than the other two—it is at any rate composed of older rocks; nevertheless it was similarly affected by the Pleistocene glaciation.

The river gorge region is on the whole a region of moderate to heavy summer rainfall, except in arid south-western Tibet, the gorges themselves often being the only comparatively dry areas. Where the summer rainfall is not

¹ J. W. and C. J. Gregory, *Geogr. J.*, *op. cit.*



Rainy Tsangpo gorge heavily forested, below Pemakochung

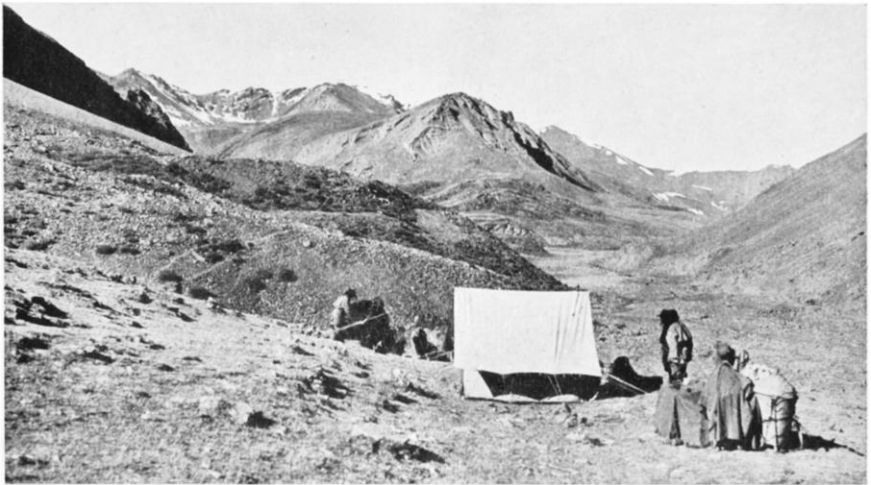


*Phot. supplied by Paul Popper
Arid Mekong gorge*



Phot. U.S. Army Air Force

Tibetan outer plateau from main Himalayan range, with Namcha Barwa on right. Central trough is valley of Tsangpo



Arid outer plateau and north slope of Great Himalayan range



Primula strumosa and P. Gambleiana growing on cattle path at 12,000 feet

particularly heavy, as in north-western Yünnan, there is usually a fairly heavy winter snowfall. Thus it is a true forest climate. The south-eastern gorge region is in fact well forested with broad-leaved, coniferous, or mixed trees according to altitude and local conditions. The tree line stands around 12,000 feet; above, forest passes into scrub and thence into alpine meadow, turf, or scree. The climax vegetation units, arranged in altitudinal belts, are of the same general type as those met with on the southern slopes of the Himalaya and in the mountains of Szechwan and Yünnan, except at the bottoms of the gorges where a distinct vegetation type may occur. The flora as a whole may be described as Sino-Himalayan, a name implying a botanical region equal with the Indo-Malaysian, Eastern Asiatic, Central Asian, and Mediterranean regions which surround Tibet and elements of whose floras enter into that of Tibet.

The population of the whole gorge country is sparse, more or less confined to the upper and lower ends of the gorges and to alluvial fans in the dry gorges, for example on the Salween, where at Chamutong (lat. 28°) wet rice is cultivated on permanent terraces. Chamutong however is at the lower end of the arid gorge, not within it. Considerable stretches of the gorges, both wet and dry, are entirely uninhabited; for example, the Tsangpo between Gyala and the Po-Tsangpo confluence except for the tiny monastery of Pemakochung where one or two people reside.

Some of the peaks, like Namcha Barwa and peaks on the Po Yigrong range north of Tsela Dzong, are over 25,000 feet high and many are over 20,000 feet. The difference between river level and the peaks within a 5-mile radius may be as much as 15,000 feet, and the contrast between the chains of snow peaks and the gorges filled with evergreen forest which they overlook is grand beyond belief. The gorge region indeed includes the most spectacular scenery in Tibet.

There are few lakes and those mainly of the small rock basin type, of glacial origin; all are fresh water, often of the most vivid blues and greens. Glaciers are numerous, the permanent snow-line standing to-day at about 17,000 feet. The glaciers of eastern Tibet are on the whole considerably smaller than those of western Tibet, in spite of the heavy snowfall in the east. The reason for this may be the generally lower mountain ranges and 5° lower latitude; also, and perhaps more significant, eastern Tibet is nearly 500 miles nearer to the sea.

The important point in the evolution of Tibetan scenery is the gradual transition from lake basin to outer plateau and from outer plateau to gorge region. The upper reaches of the Tsangpo, Salween, and Mekong were perhaps occupied by trough glaciers and by lakes. The late Sir Sidney Burrard¹ suggested that the Tsangpo originally flowed in the opposite direction—from east to west—and there is some evidence in favour of this view. If it did, it probably had its sources amongst the glaciers of Namcha Barwa and Sengdam Pu, near Gyala, where there are immense moraines. Below this point the gradient of the river bed increases very rapidly. Burrard's view requires confirmation. Yet, looking westwards up the valley from Tsela Dzong, one might

¹ S. G. Burrard and H. H. Hayden, 'A sketch of the geography and geology of the Himalaya mountains and Tibet,' part 3, pp. 155-6. Calcutta, 1907.

easily believe that the river is flowing away from one to the west. It is a curious illusion, caused partly by the decreasing height of the terraces in that direction, partly by the spurs not interlocking, partly no doubt by the diminishing height of the mountains.

But whether or not the Tsangpo once flowed west, it seems that during the Pleistocene glaciation its valley was occupied by a glacier which had not then broken across the Himalayan axis¹ and that the Dihang, also fed by glaciers, and by tremendous monsoon rains, was rapidly sapping back at its source. Eventually the Dihang cut a passage through the Gyala Peri-Namcha Barwa axis and tapped the plateau trough valley, whose waters poured through the gorge.

Tsaidam

In the north-east corner of the Tibetan plateau is a considerable depression, its average altitude little more than half that of the lake basin. This is Tsaidam. Some geographers include it in the Mongolian plateau region, perhaps because it is inhabited chiefly by Mongols. It seems to fit better in the Tibetan plateau. The average elevation is 8000-10,000 feet so that it lies some 6000 feet below the average level of the Tibet plateau; but it is also some 6000 feet above the average level of the Mongolian plateau, and since it is situated south of the Altin Tagh range (which is probably an eastward extension of the Kunlun) it is, I think, more correctly regarded as a depressed corner of the Tibetan plateau.

Not much is known about the topography of this remote region. It may originally have been an immense lake. To-day Tsaidam is partly a grassland region with fair grazing, partly a swamp; it includes a few small salt lakes. It is cut off from the outer plateau to the east and south by ranges of mountains which have not been cut through by rivers.

Chinese Tibet

The very mountainous region of western Szechwan, north-western Yunnan, and southern Kansu has been loosely called Chinese Tibet. The name is not a good one and I hesitate to use it; yet it is difficult to find a better. Neither Chinese nor Tibetans have a name for what the western geographer comprehends as a definite sub-region with underlying unity. Much of it is still unexplored in detail.

Though geologically older than the Tibet plateau proper, there can be no question of its total relationship with that region throughout the most dynamic period of geological history. And it is the Tibetan rivers resulting from the Pleistocene glaciation which have given it its present form. Chinese Tibet has in fact much in common with the river gorge region and cannot be sharply separated from it; but here *all* the principal rivers flow southwards, including the Yangtze and its eastern tributaries, the Litang and Yalung. Near the edge of Chinese Tibet the Yangtze turns north-eastwards, just as the Tsangpo-Brahmaputra eventually turns south-westwards. The latter flows along the base of the mountain range through which it has cut, and so perhaps does the Yangtze.

¹ It is possible that a glacier flowed from the Tsangpo valley over the Doshong La, a low pass immediately south-west of Namcha Barwa.

Chinese Tibet, like the gorge region in general in which it might well be included, is a region of great meridional ranges separating deep, gorge-like valleys. Many of the ranges are composed of limestone, giving a characteristic skyline. None of the gorges are so richly forested as those of the rainy gorge region farther south, nor so arid as those of the Salween and Mekong in the arid gorge region. They appear to have the same double structure, to have been scooped out first by ice, later by water. The visible alignment of the mountain ranges is north-south in Yünnan, and generally in Szechwan also; in Kansu however it is east-west. This is significant since there was less glaciation here. There are a few small lakes, as at Yungning and Chungtien, the latter more a swamp to-day but formerly a large lake which has been gradually silted up, and numbers of small glacier tarns in the mountains, for example those above Muli. On the whole, the climate of Chinese Tibet is less continental than that of the plateau. Rainfall and snowfall are more moderate, with perhaps greater humidity and certainly a smaller temperature range than on the outer plateau, although there is wide variation between mountains and valleys.

Chinese Tibet includes small grassland plateaus, *e.g.* the Chungtien plateau in north-west Yünnan, rolling moorland covered with a heather-like growth of dwarf Rhododendron, such as are frequently seen in south-western Szechwan and other parts, and many snow massifs, of which a few have names known to western geographers, *e.g.* Gongka Ling and Minya Gongka, both in western Szechwan. The diversity of scenery is probably greater than in any other part of the plateau, and there is a remarkable wealth of plant life.

It is on the whole a more fertile and more thickly populated region than any of those previously described; but the inhabitants live in isolated pockets and, owing to poor communications and to easily defensible positions, are far from uniform in language, although curiously, considering their probably diverse origin, other aspects of their culture appear to be fairly uniform, whether basically "Chinese" or, more commonly, basically "Tibetan." Towns, which are in reality no more than large villages, are confined to the outer edges of Chinese Tibet near to the plains, and to the several main caravan routes which pass through the region. These towns, which are primarily trading posts, control traffic between the plains and the mountains, and may be predominantly Chinese like Tatsienlu or predominantly Tibetan like Yungning. Essentially they are centres of trade where the two races come into close contact.

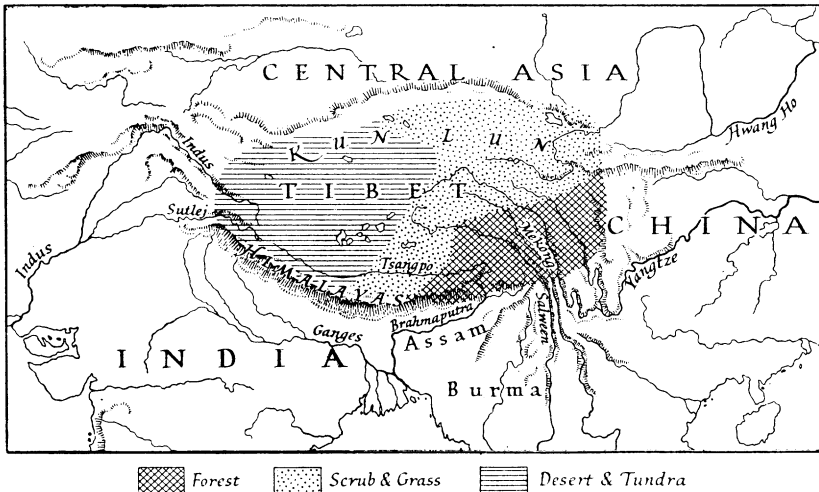
The grazing lands

Tibet cannot within foreseeable time be anything other than a pastoral country. Even in the rather unlikely event of rich mineral wealth being discovered, any activity which might result would be purely local for a long time. There is, at any rate at present, no prospect of industrialization. On the other hand, the development of flying is bound to have a considerable influence on the future of a region which has remained unchanged for centuries mainly because of its inaccessibility. There is the more reason to study its possibilities as a grazing country in the hope of improving the herds and the grazing, developing communications with the manufacturing world, and

encouraging small local industries to progress slowly. Before any of these things can be done however, we need to know a good deal more of the facts.

Most travellers have commented on the contrast between the scanty herbage on the high plateau and the great herds of grazing animals met with, both wild and domestic. Thus Colonel R. Meinertzhagen ¹ writes of Ladakh: "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. . . . Their means of subsistence is still a puzzle to me." I have myself been puzzled how the herds of domestic yak, sheep, and goats in the neighbourhood of Shugden Gumpa find enough to eat, though the alpine vegetation there is rich compared with that of Ladakh.

Wild herbivorous animals are found all over Tibet, except perhaps in the



arid gorge region. They are especially numerous on the plateau, where the following occur: sheep (*Ovis Hodgsoni*), yak, wild ass or *kyang*, Tibetan antelope (*Pantholops*), gazelle (*Piocapra*), snow leopard, and of smaller animals, hares (*Lepidus hispidus*) and marmots. Pigmy hares (*Ochotona*) occur in immense numbers on the grasslands. In the wet gorge region and in Chinese Tibet are found takin (*Budorcas*), musk deer, monkeys, giant panda, and bear. Most of the above are hunted by the tribes.

Domestic animals are kept in Tibet for the purpose of providing some of the main staples of life—wool and hair for weaving, leather and skins for clothing, and milk, butter, and cheese. Butter is used for ceremonial illumination and as a cosmetic in addition to its all important rôle as food. Yak dung is the only available fuel over a large part of the plateau. Meat is a quite secondary consideration; the Tibetans, being strict Buddhists, strongly disapprove of taking life. Since however they like meat, the sin attached to the taking of life is passed on by decreeing that butchers are outcasts.

¹ R. Meinertzhagen, *Geogr. J.* 70 (1927) 131.

The second most important use of domestic animals in Tibet is for transport purposes. Except for goats, all the common domestic animals, yak, *dzo* (a cross between the yak and Indian cattle), sheep, ponies, mules, and donkeys, are used for this purpose. It is at first sight curious that animals seem never to be used for ordinary domestic work like grinding barley, threshing, or turning wheels. But obviously culture has progressed beyond the use of animal power for such purposes: mechanical power, in the form of falling water, has long been known. Cattle however are used for ploughing. On the outer ramparts of Tibet, in the forested regions beyond reach of the church, cattle are kept by the "lopa" (*i.e.* wild tribes) purely for ceremonial purposes, though Tibetan influence and culture are infiltrating here too, as at Rima, Shugden Gompa, and in Pachakshiri.

What becomes of the herds of kyang, antelope, gazelle, and the rest in winter? It is improbable that they roam the interior plateau at that season; if they did, they would find no food. Besides, there is ample space on the outer plateau and they doubtless descend to lower levels, taking the place of the nomads, who migrate still lower. Scanty as the herbage is even in summer, we know that large herds graze on the interior plateau and that nomad tribes hunt yak, *kyang*, gazelle, and other animals at that season, while nomad herders, known as "drokpa," visit the bleak outer plateau. There are no permanent settlements in the interior lake basin or on the outer fringes of the plateau where the eastern rivers rise. There are monasteries at the sources of Indus and Tsangpo by the Manasarowar lakes, but I suspect that these are not inhabited all the year round. In eastern Tibet there are a number of small, wooden, summer monasteries which are abandoned in winter.

It is on the settled areas of the outer plateau, in the high valleys and thence to the borders of the gorge region, that the principal grazing is found, between 12,000 and 15,000 feet, though in summer the grazing may go up to 17,000 feet. In the wet gorge region there is grazing almost as high, and in Chinese Tibet also. One must beware of a too exaggerated idea of the numbers of animals involved and not count the same camp more than once as it moves progressively higher and higher up the valley. Nevertheless, there is no doubt that the total number of domestic animals is considerable. It is however limited by the one obvious difficulty of winter feed. Everywhere in Tibet the winters are long and harsh. When the plateau is completely bare, if not under snow, the stock must be brought down to the village in the valley where there is little grazing and that of poor quality. In the gorge region, herds must descend to the forest belt where there is no grazing at all except in artificial clearings.

In north Burma, in the Seinghku and Adung valleys, where Tibetan settlers have made repeated attempts to keep yak, sheep, and goats, the summer grazing above 12,000 feet is adequate, if not good, but the grazing within the forest belt—the animals have to descend to 6000–8000 feet or lower in winter—is very poor, although extensive areas are kept cleared of forest by periodic burning. However, the north Burma settlers would doubtless have succeeded in permanently colonizing these alpine valleys for stock had they been able to protect themselves from the raids by Chinese from over the border. Very considerable changes in the vegetation have been brought about

here by man in his efforts to improve and increase grazing within the forest belt.

Three types of herdsmen are found in Tibet. The nomad *drokpa* or "dokpa" depend entirely on their herds, especially yak, for their livelihood. They live in black hair tents and wander over the wide pastures of the outer plateau, moving according to the season. The *tsamba* and brick tea they need are obtained by barter for yak products. Perhaps derived from the *drokpa* are the pastoral agriculturists who live in permanent villages at or near the limit of trees, where there is good grazing. These people, inhabitants of the rainy gorge region (*e.g.* in Kongbo), depend for their livelihood mainly on their herds, but they also cultivate a little grain. Even in north Burma the herds migrate up and down and the Tibetans cultivate gardens at 8000 feet. The third type of herdsman is the hired hand who looks after the animals belonging to the well-to-do townsman and to the officials, as well as those owned by the great monasteries in the populated areas. They are not themselves cattle-kings. These men take the animals up into the high pastures in the summer and come down to the villages and towns in the winter. It is probably almost true to say that in Tibet every man, unless he be a beggar or a felon, owns at least one animal. The townsman owns a pony, the villager one or several yak, sheep, or goats and probably a pony as well.

The following table gives an idea of the superficial areas of the six natural sub-regions of Tibet. They are calculated from the map "Highlands of Tibet and surrounding regions" published by the Survey of India (1936, 1st edition) on the scale 1 : 2½M. They are in round figures and are conservative estimates:

Interior plateau ..	260,000 sq. miles	Mainly desert.
Outer plateau ..	400,000 ,, ,,	Mainly grazing. Population on the outer fringe.
Rainy gorge region	46,000 ,, ,,	Largely forest.
Arid gorge region	30,000 ,, ,,	Largely semi-desert; but forested above.
Tsaidam	37,000 ,, ,,	Mainly grazing.
Chinese Tibet ..	92,000 ,, ,,	Grazing, forest; some cultivation. Fair population.
Total ..	865,000 ,, ,,	

It is likely that at least half the above area can be grazed for at least half the year. No doubt the answer to the puzzle of where the animals find enough food is in the vast area of grazing—some 400,000 square miles. Although the traveller in Tibet cannot fail to be impressed by the large herds of both wild and domestic animals, he is likely to be even more impressed by the apparently limitless grazing. Yet it is unlikely that Tibet could, as he might suppose, carry much more stock than it does already because of the problem of winter feed, though the matter is one which should be examined closely. Without huge supplies of fodder, most of which would have to be imported, it is probable that Tibet is already well stocked.

The summer grazing might be greatly improved. Whether the type of animal could be improved it is impossible to say until we know the present

yield and quality of milk, length and quality of hair or wool, disease incidence, and so forth, so that these too must be the subject of enquiry. Another interesting question is whether other animals could with advantage be introduced into Tibet; reindeer, for example, might to-day be imported by air.

Probably butter is the most important article of food produced in Tibet. It is impossible to estimate how much butter is produced annually, though I can vouch for its excellent quality. Every Tibetan eats, or drinks, butter. Every monastery burns butter in numerous small lamps, day and night, and makes images out of butter. At present neither butter nor milk is exported, but a certain amount of wool reaches India. That Tibet could export butter and milk, or perhaps *ghee* (clarified butter), to northern India and import kerosene to lighten her darkness seems reasonable. The one form of industrialism that Tibet could carry would be a home-canning, dairy-produce industry on a limited scale. But before even so small an adjustment with the modern world is attempted, it would be wise to review the whole question in the light of facts. Improvements might be introduced gradually, but we need first to know what it is we have to improve.

Apart from improving the herds, there is the possibility of improving the grazing; again, before that is possible we must know what effect grazing has on the vegetation of Tibet. Obviously the effects will be different in different parts, according to climate, type of vegetation affected, and the nature of the interference. The animals themselves have only two means of influencing the vegetation, by manuring the soil and by selective grazing. But man alters it in several ways, notably by destroying it and by camping on it. In selective grazing, certain species are rejected, others grazed and thereby destroyed or kept in check. At camping sites the animals are tied up at night and the ground is trampled, manured, and grazed. Manuring however has little effect as the droppings are collected for fuel. In forested areas, woody vegetation is cut and burnt to extend grazing, and considerable change results.

Alpine camp sites on the plateau show very clearly their effect on the vegetation. Above 14,000 feet in the rainy gorge region, a dense growth of *Primula Roylei*, a handsome, wine-purple-flowered species, always marks an abandoned camp site. Frequently the soil is made sour and yields a thick growth of Rumex, nettle, Polygonum, Artemesia, and similar widespread weeds. Another typical weed of yak camps is *Scopolia lurida* which in winter is cut down for bedding and fodder. *Hyoscyamus niger* is also an invasive domestic weed. It would be interesting to observe these sites through the year and to see what plants come up as compared with the surrounding vegetation and how far from the camp the influence of the tethered animals extends. In many of the alpine valleys, *e.g.* between the Tsangpo and the China Road east of Lhasa, hundreds of such camping grounds exist. Their total area is not inconsiderable.

I have long suspected that certain alpine plants comprising an enormous preponderance of a single species (or perhaps of two species) found in grazing country were somehow connected with the presence of herds, and on one occasion I saw the process, or one of several processes, at work. This was in the Assam Himalaya, where yak, grazing in June at 13,000–14,000 feet, refused to eat or even to nibble the leaves of *Primula Dickieana* which

occurred in myriads in the pasture, increasing as the ground became moister owing apparently to the cutting of the *Rhododendron* scrub. It appeared that this monstrous invasion of *P. Dickieana* was due to two factors connected with grazing: one, the attempts of the herdsmen to extend the grazing area by cutting and burning all scrub *Rhododendron* in the alpine region, where the tangled bushes grew from 3 to 6 feet tall; the other, the selective grazing of the yak. The *Primula* no doubt found the conditions ideal and needed little encouragement to become the dominant species.

In the same area, at about 10,000 feet, within the silver fir-*Rhododendron* forest, was a shallow meadow basin, very marshy in June. This too was a yak pasture and contained countless thousands of the dwarf *Primula Kingii*, a plant scarcely more than an inch tall but occurring in such incredible numbers—the plants often touching one another—that the meadow was reddened by their bell-shaped corollas. It was clear that yak trampling over the pasture did not eat this plant or prevent it from seeding freely; I found abundant good seed dispersing itself in October. It appears probable that unless a change takes place and another succession more favourable to grassland intervenes, these alpine pastures will cease to be grazing ground at all.

Another example of change brought about by the presence of herds in the Assam Himalaya attracted my notice along the cattle paths through the silver fir and *Rhododendron* forest at 11,000–12,000 feet, where two species of *Primula*, *P. strumosa* with yellow flowers and *P. Gambleiana* with violet flowers, grew thickly and also hybridized. Away from the cattle paths the plants were widely scattered and no hybrids were met with. But farther north I saw meadows almost solid with large tufts of *P. strumosa* which the yak had rendered not only dominant but exclusive. Here it particularly marked camping sites, as though yak dung had proved a magic manure, or possibly toxic to every other plant.

The invariable association of these invasive plants with grazing makes it almost certain that there is some connection between them. But what exactly the connection is I do not know. Here are a few more examples: (1) Above Shugden Gompa in eastern Tibet at about 14,000 feet, several acres in a moist shallow basin on the ridge were completely covered with a species of dwarf Aster, the plants touching one another. (2) In the Lunang valley and in Tsari, and elsewhere in southern and south-eastern Tibet, were millions of *Primula alpicola* mixed with scattered species of Iris, *Primula florindae*, *Pedicularis*, and a few other less conspicuous plants. (3) In the Assam Himalayas, at 9000 feet, a species of *Ligularia* (like *Senecio*) with large cut leaves occurred profusely in clearings in the forest; this may have been the direct result of clearing the forest rather than grazing, but yak were grazing here.

Another plant which comes up freely on old camp sites and where *Rhododendron* has been cleared is *Meconopsis grandis*, which appears to flourish only where the ground has been soured and on rubbish dumps. It has spread from one or two localities in Bhutan or Sikkim within the last century. Other plants apparently associated with clearing and grazing, or with either one, which come up in great numbers, especially in alpine regions, are species of gentian (*G. sino-ornata* and others in Tibet); various species of *Pedicularis*,

which however, being semi-parasitic, may be secondary arrivals; and *Primula denticulata* (not an alpine) which increases rapidly in burnt clearings at 8000 feet in north Burma. No doubt there are many more. The mere fact that a species occurs in great numbers is not, of course, proof of domestic grazing or clearing. *Primula atrocrocea* occurs in countless thousands on a certain alpine slope in the Mishmi Hills on the Assam frontier and owes nothing to man's interference. As this is a hunting district of the Mishmi tribe however, it is possible that the colonies of *P. atrocrocea* (and to a lesser extent of *P. calthifolia* which grows with it) owe their presence to wild herds, or even to a few herbivorous animals or to ground feeding and scratching birds.

It may be noted that the mere clearing of forest above 8000 or 9000 feet in this type of country lets in certain less desirable herbaceous plants which become more or less dominant, and that clearing combined with burning lets in quite different species. The grazing of herds, the regular passage of herds to and fro, and the regular encampment of herds have each a different effect on the vegetation.

Whether, when one species completely covers the ground, e.g. *Primula Dickieana* or the dwarf Aster referred to above, the pre-climax remains stable is impossible to say at present, but it probably does so long as the same cause operates. A stage must eventually be reached when animals will no longer attempt to graze over these areas at all; and once the original cause ceases to operate there will probably be pressure from a new direction, initiating a new succession. Plant colonies, not only in the alpine region, seem to appear and disappear for no known reason. As examples I may mention the ground orchid *Paphiopedilum Wardii* which in 1930 was abundant in its type locality in the hills north-east of Fort Hertz; in 1937 I could find hardly a single specimen there. Again, *Meconopsis betonicifolia pratensis*, which was certainly not abundant in the Senighku valley in 1926, had greatly increased by 1942; by 1950 it may be extinct there. However *Meconopsis* is not truly gregarious.

In order to make the most of the extensive and probably rich grazing in Tibet and on the flanking ranges in the Assam Himalaya and north Burma, observations combined with experiments extending over several years are essential. It would probably be true to say that both the herds and the grazing could be greatly improved within a decade or two; certainly rotation grazing, not now practised at all so far as I know, could be introduced.

Although it is improbable that the Tibetans themselves are short of fats in their diet, nevertheless it seems a waste to use so much butter, a highly nutritious food, for ceremonial illumination and decoration; necessity, not religion, demands it. Kerosene would do equally well for the one, tallow for the other. The price of these articles, even before the war and on the main trade routes, was however prohibitive.

Enough has been said, it is hoped, to indicate an interesting line of research and a field for enterprise on the part of the Tibetan government which could be started without upsetting the economy of the country, bearing in mind that Tibet is an undeveloped pastoral land.