

The President of the Society then read his Presidential Address which is printed in full below. The meeting concluded with a vote of thanks from Professor R. S. Inamdar to the retiring office-bearers for their active service during the year.

PRESIDENTIAL ADDRESS

THE VEGETATION OF WESTERN HIMALAYAS
AND WESTERN TIBET IN RELATION TO
THEIR CLIMATE.

BY

PROF. SHIV RAM KASHYAP,

GENTLEMEN,

The subject which I have chosen for my address before you to-day is the vegetation of the Western Himalayas and Western Tibet in relation to their climate, and I owe you a word of explanation with respect to the choice of the subject. Last year at the Botany section of the Indian Science Congress at Bangalore I made some remarks on the vegetation of Western Tibet and you may find very little new in what I am going to say to-day. Still I have selected this subject for several reasons. The paper last year was very brief, and though the present address does not by any means do full justice to the subject, yet I have tried to make it fuller. I wish it were more comprehensive but there are many difficulties in the way, among which the vastness of the territory concerned, the difficulty of travel and collection, and the difficulty of the identification of the specimens are a few. Secondly, since last year I had another opportunity of crossing one of the Himalayan ranges—the Pir Panjal range—from the Punjab into Kashmir. Although the pass I crossed was not very high, being only 11,500 feet, yet the journey has amplified my previous observations to some extent. Thirdly, I selected the subject deliberately so that I may be able to say something about what I have actually seen myself, rather than give a summary of work done by other workers in some department of Botany which some of you no doubt could do as well as if not better than myself, or some other similar thing. It is not always possible to make broad generalisations—they only come at long intervals—and I have already given my views about the evolution of Liverworts to which group I have devoted some time, in my presidential address to the Botany section of the Indian Science Congress at Bombay a few years ago. I have not much more to add to that and I would therefore ask you to bear with me while I tell you—I

am afraid in a very general way—of the climate and vegetation of a country which is by no means easy of approach and which is visited by very few outsiders. Western Tibet as understood politically now-a-days has not been visited by any botanist so far as I know, although the neighbouring region of Ladak has been explored by several. Collections of plants made by travellers in this region have, however, been worked out by botanists now and then, though not on a very large scale. Stewart, in his paper on the Flora of Ladak, has given a full bibliography of the subject and since then the only publication of note has been, so far as I know, Sven Hedin's Southern Tibet, in one of whose volumes the botany of the country has been described. Unfortunately I have not been able to consult that work so far. The only other recent publications, in which reference is made to the plants of Tibet, are the descriptions given by the Mount Everest Expedition and Kingdon Ward's Mystery Rivers of Tibet and the Romance of Plant Hunting, all of which refer to the far eastern part of the country. The vegetation of the Western Himalayas of course is much better known though even here there is great need of intensive work. I would not, however, say much about the vegetation of the Western Himalayas except in so far as a contrast with it might bring out the characters of Tibetan vegetation more clearly. One might of course say a great deal about the vegetation of the Himalayas—its great variety, periodicity and other phenomena present an enormous amount of material for the enterprising student.

Boundaries:—Tibet, as you know, has had a mysterious and fascinating influence over a great part of the rest of the world, and the difficulties of approach owing to conditions both physical and political, has only added to the curiosity which people have felt with regard to it. This name is given to that vast tract of country which lies between China and the Pamir plateau on the one hand, and the Himalayas and Chinese Turkestan on the other. The great wall of the Himalayas, about 2000 miles long, separates it from India. The extreme Western part of this tract is known as a whole as Ladak and is now-a-days politically under Kashmir, but climatically and geographically it is as much a part of Tibet as any other part of that country. Even politically it was connected formerly with Tibet. Its people are like the rest of Tibetans in physiognomy, religion, customs, habits, etc. Under Western Tibet I include that part of the country which extends from the Indus to the region of the holy lakes Manasarowar and Rakastal. It is a hilly country with flat plateaus of a very high altitude, usually not less than 12,000 feet and often much higher, while the mountain peaks scattered about which look like small hills owing to the high initial altitude are mostly above 20,000 feet.

In order to reach this country from India one has to cross the Himalayas at some place or other. This crossing is usually effected at relatively low depressions, the passes, the lowest being in Kashmir, the Zojila, about 11,000 feet above the sea level. Of course these passes are open in summer only. The only other way of reaching Tibet is by going up the banks of the rivers which arise in Tibet and break through the Himalayas to come to India. These rivers are the Indus on the extreme west, the Brahmaputra towards the east, and the Sutlej and the Karnali about the middle, and the sources of the three last mentioned rivers are very near each other. It is the portions of this tract extending from the sources of the Sutlej and the Karnali to the Zoji la which I have passed through on four different occasions.

Climate :—The climate of Tibet is mainly determined by its own elevation and by the huge wall of the Himalayas which offers an effective barrier to the water-laden monsoon currents from the Indian Ocean. Practically all the moisture is precipitated to the south of the Himalayas and whatever does reach the country beyond is deposited mostly in the form of snow. Towards the eastern part of Tibet some moisture does reach the country and as a consequence the vegetation of those parts is better developed than that of the rest of Tibet. At Lhasa the annual rainfall is 14 inches.

I will now describe briefly the chief features of the Tibetan climate.

1. *Extremely small precipitation*.—Exact figures are available only for Leh in Ladak where it is said to be only 3 inches annually. Leh, by the way, is about 11,000 feet in altitude, and a few miles from the right bank of the Indus. The same would no doubt be true of the rest of Western Tibet, from what I have seen of it. It is interesting to compare this rainfall with the rainfall on some of the stations on the south side of the Himalayas. Near the point where the Chandrabhaga takes its origin, the main Himalayan range divides into three more or less parallel ranges, of which the outer is the lowest and the inner the highest. The inner and the middle are mostly separated by the Chandrabhaga valley, and the middle and the outer by the Ravi valley. The rainfall (including the winter snowfall) at Kyalang in the upper valley of the Chandrabhaga is 6 inches. At Leh we have seen it is only 3 inches. The rainfall at Chamba in the Ravi valley and at Nagar in Kulu (Beas Valley) in a similar situation is 47 inches. The rainfall in the stations on the outer Himalayas is usually something between 50 and 100 inches. It is clear from this how effective is the barrier of the Himalayas. Some moisture can penetrate into the range for a longer distance up the valleys of the

rivers which break through the Himalayas, but the courses of these rivers are so long, so circuitous, and the gorges are so narrow that the effect on the vegetation is very slight.

2. *Temperature*.—Exact records again are not available, but it will be enough to say that the minimum is exceedingly low. Even in summer water freezes at night in many places and in winter of course the temperature falls very low indeed.

3. *Insolation*.—Owing to the great rarefaction of the atmosphere which cannot absorb much of the solar heat, the rays of the sun are very strong, but in shady places and as soon as the sun is down radiation is equally rapid and the temperature falls. Evaporation is for the same reason very rapid.

4. *Wind*.—Strong wind which usually blows in the afternoon is another important characteristic of the climate. It is intensely cold and exceedingly dry, so much so that under its influence the skin of the exposed parts of the body is quickly cracked unless it is protected by some greasy substance.

Vegetation :—The effect of these climatic conditions prevailing on the two sides of the Himalayas is to produce vegetation of extremely different types on the two sides.

Generally speaking there are luxuriant forests with all the usual accompaniments of other forms of vegetation on the southern slopes, whereas the country is a barren desert on the northern side. And this transition is quite sudden, occurring within the distance of a few miles.

The luxuriance of vegetation naturally decreases from the east to the west on the Indian side owing to the gradually decreasing rainfall and to the fact that the course of the Himalayas is from south-east to north-west, and the western portion is therefore in a higher latitude, and thirdly to the fact that the western portion is more distant from the sea.

The vertical sequence of vegetation in the Garhwal Himalayas has recently been described by Osmaston in the *Journal of Ecology*. It may be stated in a very general way that the vegetation at the foot of the outer hills is of a sclerophyllous type; a little higher between 2,000 feet and 5,000 or 6,000 feet forests of *Pinus longifolia* are met with; which becomes gradually mixed with *Quercus incana*; still higher other oaks, *Q. semecarpifolia* and *Q. dilatata*, with *Cedrus deodara*, *Pinus excelsa*, *Picea morinda*, *Abies Pindrow* and higher up *A. Webbiana* (Plate I). There are of course other broad-leaved trees in addition but the forests formed by the above are very conspicuous. In the inner drier valleys the forests are formed by *Pinus Gerardiana* and *Cedrus deodara*. This is for example the case in Kunawar (Upper Sutlej

valley) and Lahoul, Pangi and Padar (Upper Chandrabhaga valley). These trees extend to about 10,000 feet or so. Still higher up in these valleys we find small forests of *Juniperus religiosa* and *Betula utilis*, the bhojpatra. The altitudes to which the plants given above extend tend to be lower and lower as we proceed to the west, owing to the gradual descent of the snowline. Thus we find the bhojpatra occurring at about 8,000 feet in Kashmir below the Zoji la. *Juniperus religiosa* and *Betula utilis* form the tree limit.

In the outer parts of the Western Himalayas at lower levels we come across rich undergrowth of herbs in the eastern part but towards the west this undergrowth becomes less luxuriant. In the eastern part there are numerous epiphytic orchids and epiphytic ferns, for example, in the Kali valley near Askot along the borders of Nepal at about 3,000 feet or so above the sea; at Dehra Dun, 2,000 feet above the sea, we have a few epiphytic orchids and epiphytic ferns, while at Mussoorie, a few miles higher up at about 5,000 to 6,000 feet and also at Simla (about the same altitude), there are many terrestrial orchids and ferns but practically no epiphytic orchids; still further to the west at Dalhousie, Murree and other similar places there is a great paucity of even the terrestrial forms of orchids. Epiphytic orchids and ferns are absent in the drier inner valleys like those of the Chandrabhaga and the Sutlej. Even the terrestrial forms are either absent or very scarce. The distribution of the Liverworts and their relation to climate I have described elsewhere.

Above the tree limit we get grassland extending up to the perpetual snow. The hills which consist of hard rock or for some other reason have very little water are naturally bare, but as a rule we find grass-covered hills right to the snow line, and in many cases to the top of the passes. Many herbs with brilliant flowers are met with in the grass, such as species of *Anemone*, *Geranium*, plants of the family *Gentianaceae*, etc. Species of *Saussurea* with a tufted habit are especially conspicuous at very high levels, in Garhwal and Almora. One of these is used as a sacred offering at the temple of Badrinath under the names of Blue Lotus.

In the river valleys which cross the Himalayas the changes, in climate and the corresponding changes in vegetation are not so sudden. The vegetation passes gradually into more and more xerophytic forms. This is especially the case in the Sutlej valley.

Once across the Himalayas the view is entirely changed all of a sudden.

1. There are practically no trees to be seen. It is only here and there in sheltered low places with plenty of water in streams that a few willows and poplars are met with cultivated by villages. Stunted

trees of *Juniperus religiosa* occur in Ladaḳ, which is also fortunate in having some cultivated fruit trees also in its western portion, the chief among them being the apricot. Incidentally it may be pointed out that owing to the rigorous climate cultivation of a few plants is possible only in a few particularly low sheltered places where water is available for irrigation, and villages are therefore met with at very long distances. One may travel for days without coming across any habitation or even seeing a human being. People live a nomadic life, which is the only possible general mode of life.

2. The most important and conspicuous character of the vegetation is the cushion-like habit of practically all shrubby plants. The compact cushion-like habit protects these plants from the intensely cold dry winds which would otherwise kill them by their great drying power. As a rule these plants have spinous tipped leaves and in some, *Caragana* for example, the shoots are actually modified into spines. It is not quite clear why xerophytic plants should be spinous as they so generally are. It appears to me that the spinous condition is not so much a protection against the climate as a protection against animals. Plants growing in deserts are not so well off in numbers as to afford to be eaten away by every animal that comes along, and therefore they have to evolve some protective mechanism against animals.

The most conspicuous plant of this kind, and which is most characteristic of the vegetation of Tibet, is undoubtedly *Caragana pygmaea* (Plates II and III). Its hemispherical cushions occurring at a distance from each other give a peculiar appearance to the landscape. It occurs in large numbers (comparatively speaking) on the plains, such as the Lingti plain, the Kiang Tso plain, the plain near the holy lakes, and other places, at various levels between 12,000 to 15,000 feet. In the Sotlej valley, however, it is met with for the first time in going up, on the top of a ridge, the Piving la, 15,400 feet in height. This fact also illustrates the difference in climate and the corresponding change in vegetation of the river valleys and the Tibetan plains. Fairly delicate plants are sometimes met with hidden under the clumps of this shrub. I noticed this particularly at the Piving la. The comparative mildness of the climate in this region is also indicated by the presence of a large number of cultivated trees on both sides of this pass at its foot. Beyond this trees are practically absent.

Two species of *Arenaria* are almost as characteristic as *Caragana* but they are much smaller. The larger of the two, *A. polytrichoides*, (Plate IV), is usually met with growing in the fissures between stones but it is also met with in the open, and may attain a diameter of 2 feet or more. The photograph given herewith was taken on the top of

Lachaung pass, 16,500 ft. or so. The other and smaller species, *A. musciformis* (Plate V) grows in large numbers forming small hemispherical cushions at a distance from each other. I came across this plant on the plain of Barkha near the Manasarowar lake.

Acantholimon lycopodioides is a plant of the family Plantaginaceae and is exactly similar in habit (Plate V). It is abundant in some parts of Ladak.

The same is the case with several species of *Astragalus*, on a small scale.

All these plants are so compact in habit that there is hardly any indication of branching from the outside, but when seen from below numerous branches can be seen (Plate V). All of them have long tap roots.

Since the growing season is very short, being limited to a few summer months, the new growth in each plant is very small. The plants may for this reason be very small yet they may have been growing for scores of years. For the same reason annuals, whenever they can grow near streams, complete their life cycle in a very short time, and consequently remain very small, sometimes minute. Among other plants not so common and not so conspicuously cushion-shaped, but still characterised by long roots, copious branching, small leaves, and often hairy covering, may be mentioned species of *Geranium*, *Potentilla*, a species of *Allium* used as a spice in Tibet and also exported to India which I came across near Gyanima and later on other places also, *Eurotia ceratoides*, *Ephedra vulgaris*, and species of *Astragalus*. All these are characterised by one or more xerophilous adaptations. Another interesting plant with comparatively large leaves, but protecting itself by a prostrate habit is *Capparis leucophylla* with its large white fragrant flowers full of honey common in some parts of Ladak. It is also met with at much lower levels on the Indian side of the Himalayas. I came across it near Rampur only 3,000 feet above sea level, and several other places in the Sutlej valley. In many places one finds no vegetation except small tufts of grass at a distance from each other covering large areas, and it is this grass which serves for the subsistence of the huge herds of sheep and yaks which are again the means of subsistence for the human beings.

Again in some places vegetation is wholly absent and the sandy soil or the hard rocks present a bare desolate sun-dried appearance giving the scenery its wild grandeur (Plate VI).

In a few comparatively favourable places we find small patches of fairly delicate plants but such localities are not common. They are the

banks of streams in low sheltered places, swampy tracts or near artificially irrigated fields. Such patches are met with in the Lingti plain at Serchu, at Shuchalam, and at Taklakot. At the first two places an interesting plant is a stoloniferous species of *Ranunculus*, *R. Cymbalaria*, a tiny prostrate plant with small yellow flowers. Other plants occurring in such places are two species of *Myricaria* common in many places, especially at Manglang; yellow and red-flowered species of *Pedicularis*; species of *Draba*, some times very minute; and some small *caryophyllaceous* plants; while among those requiring a little less moisture may be mentioned species of *Corydalis*, *Rumex*, *Polygonum*, species of *Geranium* and *Potentilla*, *Hyoscyamus niger*, *Chenopodium album*, *Convolvulus arvensis* (perhaps introduced at Taklakot), an *Urtica*, a *Dianthus*, and some plants of the *Fumariaceae*, *Boraginaceae* and *Acanthaceae*. Some of these plants are interesting as occurring on both sides of the Himalayas, and right over the pass in some cases showing perfect continuity of distribution. Even the characteristic *Caragana* is occasionally met with on the Indian side.

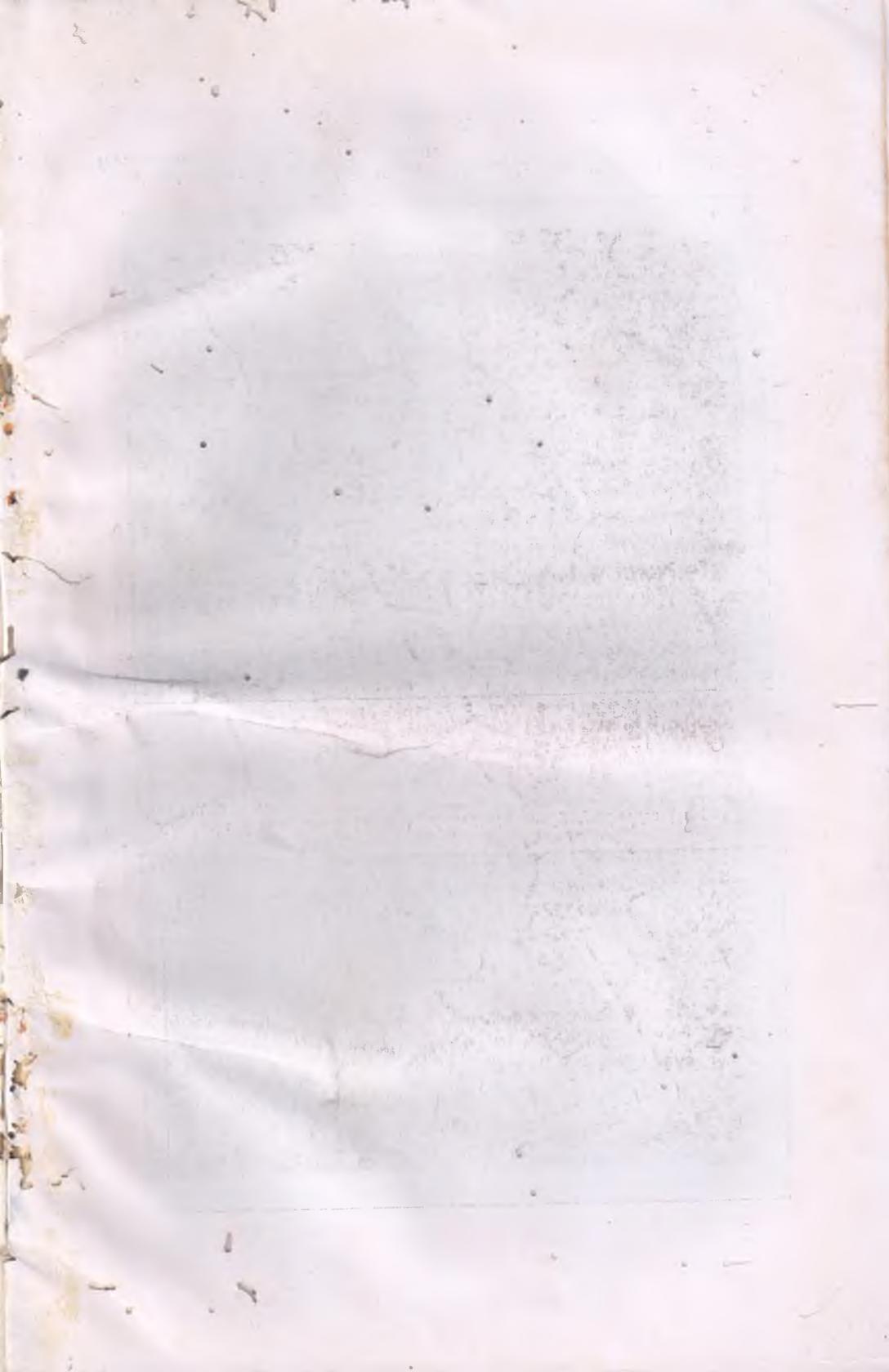
Aquatic vegetation is very scanty and whatever there is of it is similar to that met with on the Indian side. It is not possible to say whether the species are identical. Probably not. In the Manasarowar lake I found a yellow *Ranunculus*, a *Potamogeton*, and a *Myriophyllum*. On the banks I saw what looked like a *Nostoc*. The aquatic vegetation is undoubtedly very scanty, both in the number of species and in the number of individuals.

Such is the condition of Western Tibet as regards its vegetation. Yet people not only live there but actually enjoy life. They have become so adapted to their surroundings that they do not care to come to lower levels except for short periods in winter, and they roam about in these high altitudes with their flocks of yaks and sheep. Even the trade marts are purely temporary collections of tents for two months or so, and these places are absolutely deserted during the rest of the year.

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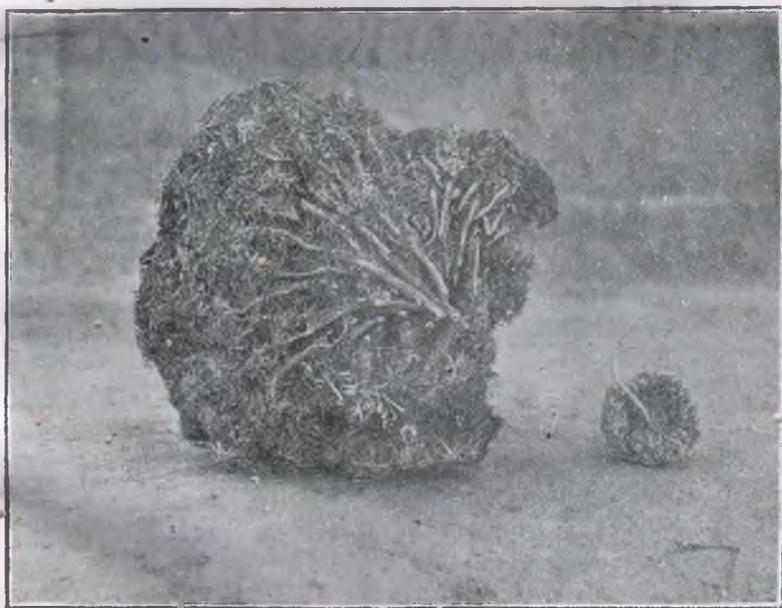


Plate VI. Camp at Rukchin (Rupshu, Ladak) nearly 16,000 feet; shows the average general view of the country.

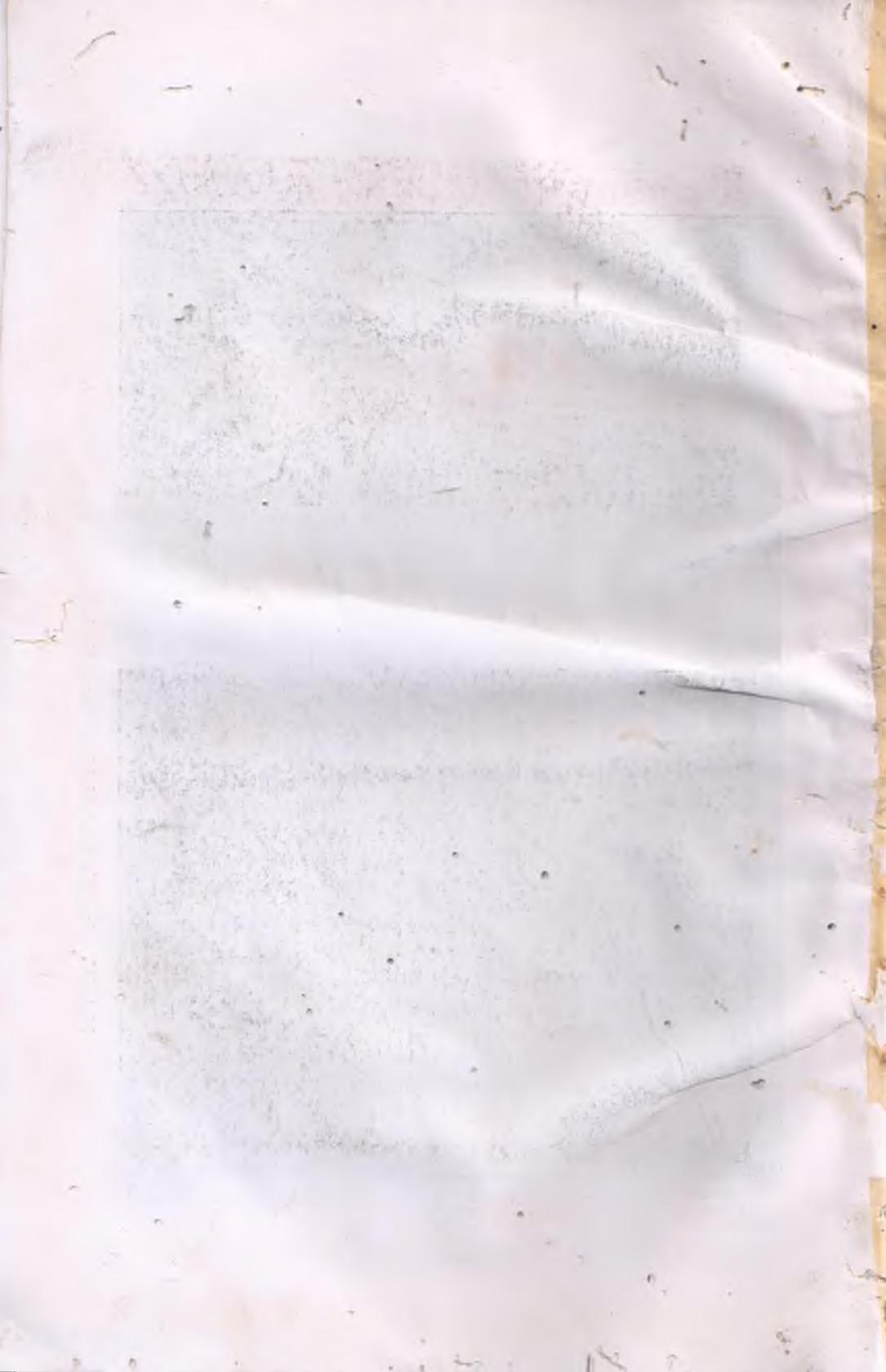




Arenaria musciformis (small), *Acantholimon lycopodioides* (large) Ladak.
About 12,000 feet.



Acantholimon lycopodioides (large). *Arenaria musciformis* (small). Seen
from below. Ladak. About 12,000 feet.



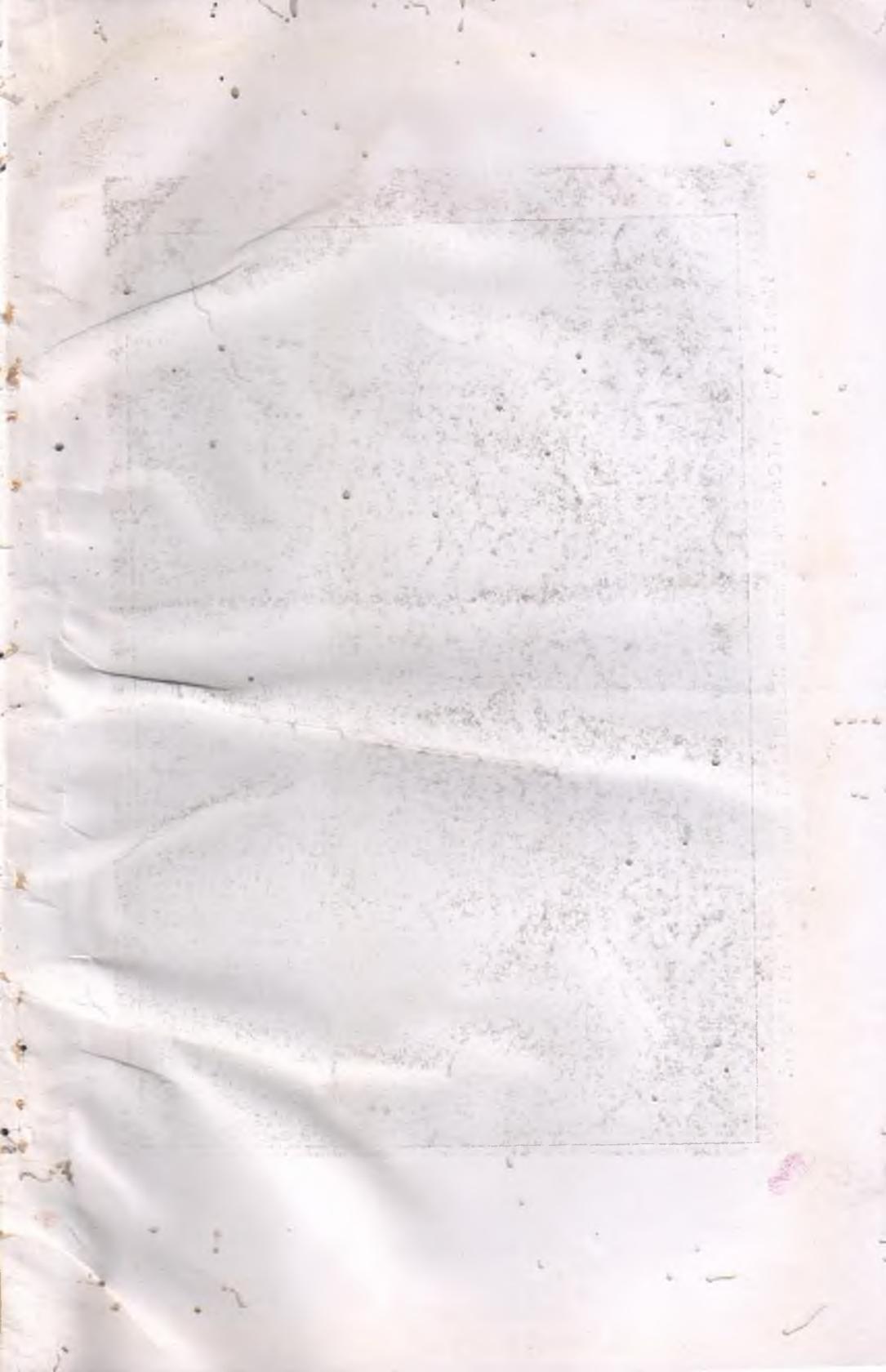




Plate III. Clumps of *Caragana pygmaea* near Rakastal lake, Western Tibet. About 15,000 feet.



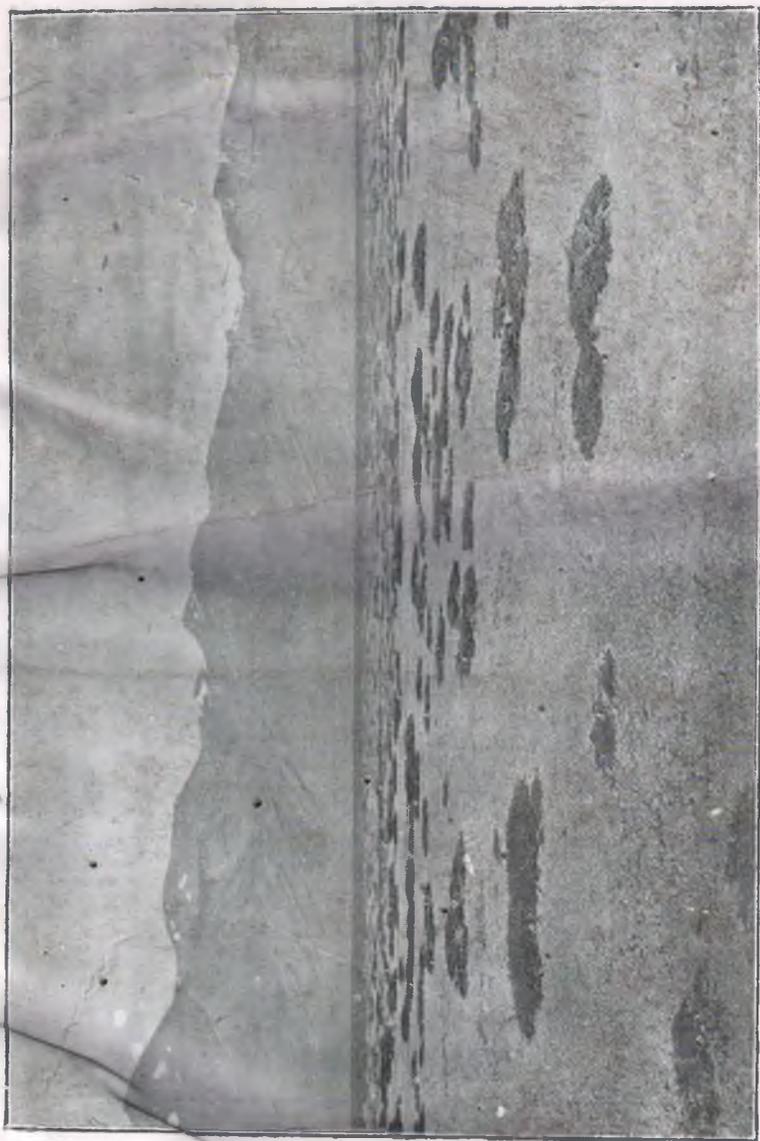
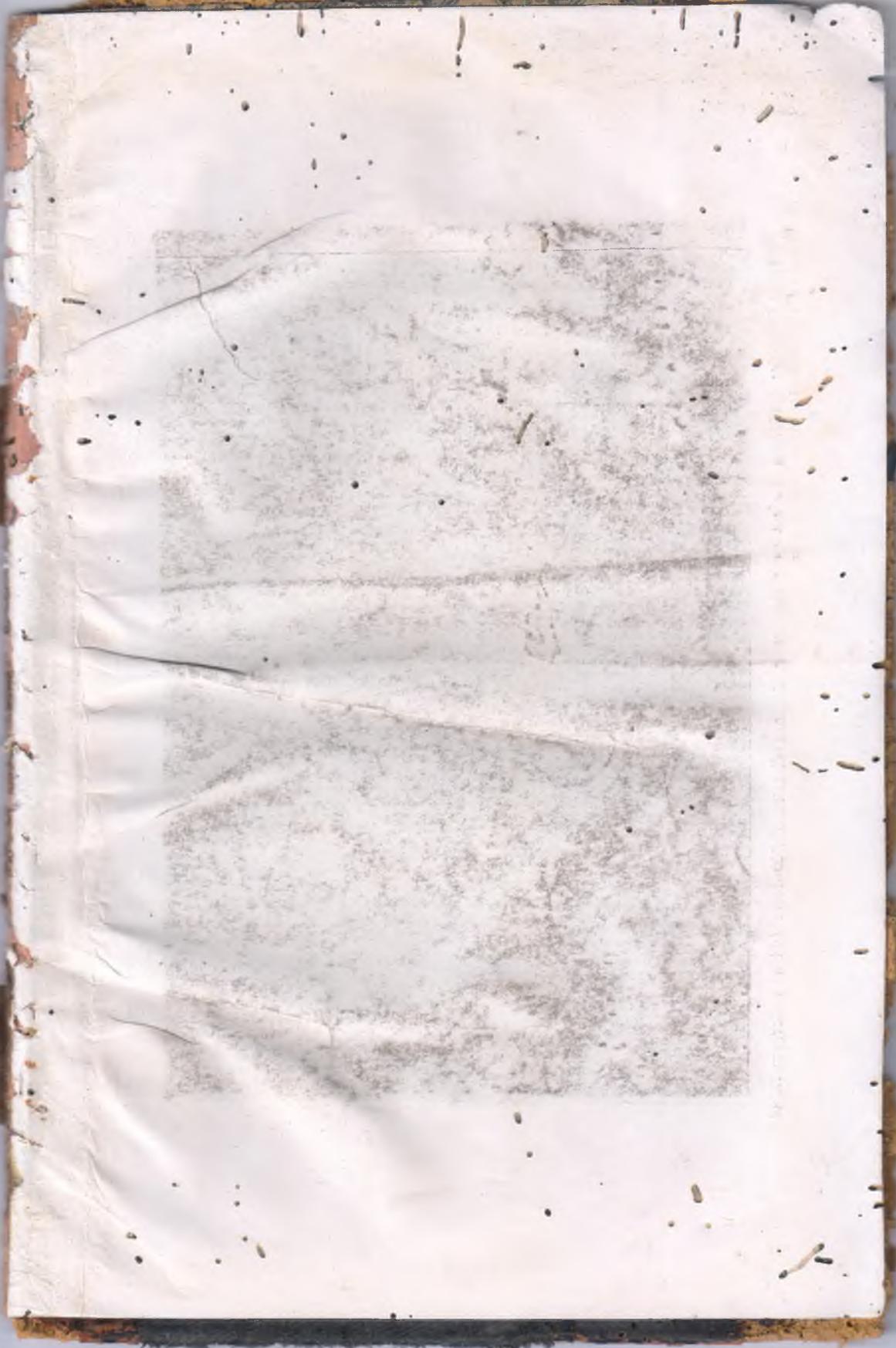


Plate II. *Caragana pygmaea*, bushes on Kiang tso plain, Rupshu. Two plants of *Arenaria polytrichoides* in the middle foreground. About 15,000 feet.



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Plate I. *Abies Webberiana* Forest near Garbyang, Almora district, 10,000 feet. (with undergrowth of *Osmunda claytoniana*)

