

SOME BOTANICAL ASPECTS OF KASHMIR

R. N. CHOPRA* & L. D. KAPOOR**

IT is a great honour to contribute to the commemoration volume which the Governing Body of the Institute of Palaeobotany, Lucknow, is publishing to honour the memory of its great Founder-Director, the late Prof. Birbal Sahni. Prof. Sahni's untimely death is a great loss to science generally and palaeobotany particularly in which he attained an almost unrivalled position in the world. His contributions in the field of palaeobotany in India have made him an outstanding figure among scientists of the world.

Prof. Sahni was very greatly interested in the fossil flora of Kashmir and to study this he made many trips to almost every nook and corner of the happy valley. He used to visit Kashmir almost every year. The senior author well remembers how, after collecting data from everywhere, he used to settle down in Gulmarg to study, analyse and write it up. He further remembers how, during the course of their walks, he used to pick up a piece of rock and explain how it reflected the past. Later his students took up more detailed work in the study of fossil flora in the Karewas of the valley and Pir Punjal beds, which throws a flood of light on our knowledge of the Pleistocene flora of Kashmir. Dr. G. S. Puri (1947) has done extensive systematic work in this connection, but there is still a vast field for the palaeobotanists to explore the past ancient history in this valley. A study of the present flora of Kashmir might help us to understand the significance of palaeobotanical investigation carried out by Prof. Sahni.

Kashmir has gained great importance in the field of politics during the past three years, but it has been none the less important on account of its luxuriant flora which has been the subject of study of many distinguished botanists. Geographically, Kashmir is an area where great empires meet, but botanically a number of diverse floras mingle to create the present assemblage of plants. A brief note on the flora of this beautiful valley may be worth recording.

The whole of Kashmir region is a highly mountainous tract and the only valley of size is the main valley of Kashmir situated at an altitude of a little over 5,000 ft. above sea-level with about first 100 miles of Jhelum river running through it. The main ranges of the Himalayas, running roughly from east to west, divide this area into two, creating a high level desert region or the inner dry valley to the north. The fertile, well-forested portions are towards the side of the Indian plains, still largely unexplored from the point of view of palaeobotany. Below the alpine zone the southern slopes of the Himalayas are covered with beautiful forests and grasslands and with scrub forest at the foothills. The trans-Himalayan part of this tract is largely Tibetan in character and most of the inhabitants are of the Mongolian race. This extensive region is almost treeless and most of it is a waterless desert.

The mountains of Kashmir are among the highest in the world, culminating in Nanga Parbat (26,669 ft.) in the west and the Mount Godwin Austen (28,265 ft.) in the Korakorum in the far north. This trans-Himalayan region is drained by the upper Indus which flows from east to west and then turns towards the plains after circling the Nanga Parbat range.

There are two large rivers which drain the portion of Kashmir to the south of the Himalayas; these are the Chenab and the Jhelum with their numerous tributaries. This part of the State is largely forested though certain areas are covered with grass and shrubs and in the drier inner valleys grass is replaced by *Artemisia*.

Geologists agree that what is now Kashmir was under the sea until the Tertiary period, and that the Himalayas have risen in comparatively recent geologic time. In fact, they are probably still rising. During the Pleistocene period there were four advances of the glaciers and most of the area down to altitudes of 5,000 to 6,000 ft. was under ice at least once. This means that the present flora is comparatively recent. This is borne out by the fact that there are abundant

* Research and Technical Director, Drug Research Laboratories, Kashmir.

** Chief Botanist, Drug Research Laboratories, Kashmir.

fossil remains in clay on the north slopes of the Pir Punjal range from one of the interglacial periods, which show that the flora at that period was a good deal different from what it is now.

The zones of vegetation in Kashmir are much like those of the rest of the Himalayas towards the east, modified by the smaller amount of rainfall, and the fact that the country is further north reduces the eastern and tropical elements in the flora. The south-eastern corner in Jammu province is the most tropical and this element decreases as one goes towards the North-west Frontier Province. The rainfall similarly decreases as one goes from the Chenab towards the Indus on the west.

The submontane zone is naturally the most tropical. It begins at an altitude of 1,200 ft. at Jammu, at 1,000 ft. in Mirpur and 1,900 ft. at Kohala on the Jhelum Valley road. This zone is very dry most of the year, very little rain falling except in July or August. It is largely covered by mixed thorny scrub until *Pinus longifolia* begins at 3,000 ft. At first there are only scrubs such as *Adhatoda vasica*, *Dodonaea viscosa*, *Zizyphus nummularia*, *Sageretia theezans*, *Gymnosporia royleana*, *Carissa spinarum*, *Otostegia limbata*, etc. With increasing altitude the plants become taller and larger species enter the picture. Species of *Grewia*, *Acacia modesta*, *A. catechu*, *Mallotus philippinensis*, *Olea cuspidata*, *Punica granatum*, *Ficus* sp., *Bombax malabaricum*, *Pistacia integerrima*, *Cassia fistula*, *Melia azedarach*, *Cedrela toona*, *Bauhinia variegata*, *Caesalpinia sepiaria* and many more.

While *Pinus longifolia* begins on the rocky spurs and ridges, the mixed scrub forest takes the gentler slopes to an altitude of about 6,000 ft. The pine gradually becomes more and more abundant forming pure stands covering large areas. Towards the upper limits of *Pinus longifolia* the xerophytic oak, *Quercus incana*, becomes abundant on the outer ranges. At about 6,000 ft. a more temperate flora comes in which includes many genera of broad-leaved trees and *Pinus excelsa* begins to replace *P. longifolia* on the more sheltered hillsides. *Quercus incana* and *Quercus dilatata* are very common from 6,000 to 7,000 ft. on the outer ranges. Common broad-leaved genera are *Prunus*, *Aesculus*, *Pyrus*, *Crataegus*, *Morus*, *Celtis*, *Ulmus*, *Euonymus*, *Fraxinus* and *Acer*. *Abies webbiana* begins

at about 7,000 ft. and *Picea smithiana* may be locally abundant. *Taxus*, too, may be common in the damper forests. The deodar is not common on the outer ranges but becomes abundant on the drier inner mountains. In the Jhelum Valley road and in Kishen Ganga Valley it is the commonest tree.

The finest forests are usually at an altitude of 6,000 to 9,000 ft. Above 9,000 ft. the trees decrease more or less gradually in size to the tree line at 11,000 to 12,000 ft. Conifers dominate this zone all the way to the tree line. The fir is the commonest tree with the blue pine second in importance in the upper forests. In many places white birch, *Betula bhojpatra*, forms a narrow zone above the conifers.

The birch is a hardy pioneer and re-occupies valleys in which the vegetation has been destroyed by avalanches.

Above the tree line there may be either alpine meadows or a zone of shrubs. On rocky spurs and ridges dwarf junipers are conspicuous. There are only two gregarious Rhododendrons in contrast to the numerous species in the Eastern Himalayas. *Rhododendron campanulatum* is locally common and a little higher there may be a belt of *R. hypenanthum* or patches of dwarf willow, particularly *Salix denticulata*.

CHIEF ELEMENTS IN THE KASHMIR FLORA

Lying near the centre of a continent, the flora has such features which have come in from all sides. The floras of the different zones have very different affinities. The plants of the alpine zone are related to the plants of the Arctic area and to the alpine and temperate plants of Europe and Asia. Many Kashmir alpine plants are found in the whole of the Arctic zone of Europe, Asia and America. Many others are to be found in the high mountains, from the Alps of Europe clear across Russia to the Pacific. Others are limited to the highlands of Central Asia and Tibet. A very large number are Himalayan with a distribution from Afghanistan or Kashmir to Sikkim or even China. Many more, as far as we know, are endemic. The Himalayan element is probably the strongest in the forest zone from an altitude of 6,000 or 7,000 ft. to 10,000 ft. The Mediterranean and tropical elements are commonest in the foothill zones.

As eastern extension of the Mediterranean flora is found in the valley of the Indus behind the main Himalayan range, in the valley of the Jhelum up to an altitude of about 5,500 ft. and on the upper Chenab, some of the plants are to be found in the arid belt which stretches from the Atlantic, on both shores of the Mediterranean across Palestine, Arabia, Persia, N.W.F.P. and the Punjab. *Tribulus terrestris*, *Malcolmia africana*, *Euclidium syriacum*, *Capparis spinosa*, *Peganum harmala*, *Linum strictum*, *Lamium amplexicaule*, *Dianthus anatolicus*, *Koelpinia linearis*, *Chenopodium botrys*, *Daphne oleoides* and *Epipactis consimilis* are examples from the Mediterranean flora which are to be found in the dry Tibetan parts of Kashmir.

As previously mentioned, the tropical elements in the Kashmir flora is to be found chiefly in the foothill zones and is best represented in Jammu province and along the lower Chenab and its tributaries but many species extend as far as the Indus. There are many trees and shrubs belonging to well-known tropical genera including *Kydia*, *Bombax*, *Zanthoxylum*, *Desmodium*, *Flacourtia*, *Xylosma*, *Pittosporum*, *Thespesia*, *Cassia*, *Erythrina*, *Flemingia*, *Caesalpinia*, *Dalbergia*, *Bauhinia*, *Wikstroemia*, *Zizyphus* and *Mallotus*.

Similarly, in the Himalayan forest zone it is probable that the present flora has come in both from the east and the west. *Potentilla nepalensis*, *Pyrus pashia*, *Rumex nepalensis*, *Machilus* sp., *Litsaea* sp., *Elaeagnus umbellata*, *Viscum japonicum*, *Morus serrata*, *Buddleia asiatica* and *Quercus glauca* are examples of eastern plants. Various species of *Ranunculus*, *Stellaria*, *Viola biflora*, *Silene viscosa*, *Oxalis acetosella*, *Geum urbanum*, *Morina persica* and many more may have come from the west through Afghan mountains.

A large number of species in the alpine zone of Kashmir are found throughout the colder parts of the northern hemisphere. Some familiar examples are *Thalictrum alpinum*, *Papaver amaenum*, *Lychnis apetala*, *Astragalus frigidus*, *Potentilla sibbaldi*, *Pyrola rotundifolia*, etc.

Another large group may be called Eurasian as the species are found in the colder parts of Europe and Asia. Some examples are *Stellaria graminea*, *Valeriana dioica*, *Orchis latifolia*, etc. Many species belong to the Central Asian flora. Some

examples are *Corydalis stricta*, *Geranium collinum*, *Sedum ewersii*, etc. As might be expected, the plants of Baltistan and Ladakh, to the north of the Himalayas, have the largest percentage of Central Asian plants.

A smaller group of species appears to be Tibetan. The flora of the trans-Himalayan parts of Kashmir is essentially Tibetan, especially in Zanskar, Rupshu, Ladakh and parts of Baltistan. Most of the area is desert and the only trees seen are cultivated in the villages. There is no continuous sod except near streams and near the snow-line. The plants are dwarf, perennials, tufted grasses and sedges, cushion plants and rosette plants. There is heavy snow-fall in the winter on the mountains but there is hardly any rain. The rainfall at Leh, the capital of Ladakh, is two inches a year and the whole country is dry except at very high altitudes near the melting snow or where a few acres are irrigated with great labour. The flora is naturally very different from that of the rest of Kashmir.

Further west, about Nanga Parbat in Astore and Gilgit district, conditions are a little more favourable and there are some forests. Common plants in the river thickets are willows, *Rosa webbiana*, *Ribes orientale*, *Hippophae rhamnoides* and *Tamarix*. In Astore there are park-like forests of the xerophytic *Pinus gerardiana* and the almonds grow wild. It would be interesting to know if the almond originated in this part of the world.

One of the most interesting regions in Kashmir from the point of view of a botanist is the Deosai plain, a well-watered alpine region east of Astore, south of Skardu and west of Dras. Here there is an extensive region above the tree line covered with tundra much like that of the Arctic. There are hundreds of square miles of boggy soil where clouds of mosquitoes make life miserable in the summer. Sedges and grasses are common with a large number of species of alpine type.

It would be no exaggeration to say that the Kashmir State presents more or less cosmopolitan flora. In addition to what might be found endemic here, there are tulips, irises, *Sternbergia*, *Ixiolirion* and a few other plants in the valley which may have been introduced by the Moghals and are now to be found naturalized,

especially in the graveyards and saffron fields. The ubiquitous Lombardy poplar and *Platanus orientalis* (chinar) trees have also been introduced.

Kashmir is rich in water plants also, especially in the main valley. As in other parts there are largely cosmopolitan species. The Wular, the Dal, the Anchar and other lakes are full of water plants and the villagers make full use of the harvest of the lakes, building floating gardens, making matings from the cat-tails, gathering *Limnanthemum* to feed their cattle, gathering *Trapa* fruit (singharas) for food and digging up the mud and decaying vegetation of the lake bottom for manure.

The lotus, white water lilies, *Limnanthemum*, *Euryale ferox*, *Polygonum amphibium*, *Utricularia flexuosa*, *Hydrocharis morsur-ranae*, *Trapa bispinosa*, *Menyanthes trifoliata* and several species of *Potamogeton* are among the most interesting of the water plants in the main valley.

Jammu and Kashmir State is not only rich in its wide range of flora from a botanist's point of view but many drug plants and other plants of economic value also grow here. It has been seen that plants like *Atropa acuminata* and *Hyoscyamus niger* grow in the forests and contain high percentage of active principles. The other drug plants such as *Podophyllum emodi*, *Rheum emodi*, *Saussurea lappa*, *Picrorhiza kurrooa*, *Artemisia brevifolia*, etc., grow here in abundance to meet the Indian demand for medicinal purposes.

Similarly, mention may be made of about 50 of the essential oil-bearing plants including *Skimmia laureola*, *Archangelica* sp., *Angelica glauca*, *Carum carvi*, *Mentha arvensis*, *M. piperita*, *Juniperus* sp., Lavender and *Ferula narthex*. Many of these can be exploited for such purposes as the cosmetic industry and also for medicinal purposes.

The suitable climatic and soil conditions in Kashmir can also provide a ready field for the cultivation of such important vegetable insecticidal plants like *Chrysanthemum cinerifolium* (Pyrethrum) and many other economic plants.

As a matter of fact, our knowledge of the Kashmir flora is still far from complete. Neither a flora nor a catalogue has been published and although many people have collected in the State, few have published anything about their collections. There is plenty of work still to be done not only

in ecology and plant geography but also in systemic collecting. The eastern boundary of the State towards Chamba and Dalhousie has been visited by few botanists and as it has the highest rainfall, there are probably species in this region which do not grow elsewhere in Kashmir. If there are any epiphytic orchids and ferns in the State, they may be expected on the eastern border.

Prof. R. R. Stewart has made quite an extensive collection of the plants from Kashmir. He says: "I now have about 2,650 names in my lists and so it is safe to say that there are at least 3,000 species growing in the area. This is a large number for a small continental area of about 84,000 sq. miles lying largely in the temperate and alpine zones. Because of the great altitudinal range, 18,000 ft., and the great difference in rainfall and exposures, there are many different climates in the State, permitting a great variety of plant life to develop.

"In the arid regions behind the Himalayas, plants have been collected up to 19,000 ft. which is as high as plants have been collected anywhere. The snow-line is lower on the ranges south of the main range and there the snow-line is usually around 14,000 to 15,000 ft.

"Of the species I have listed about 2,117 are dicotyledons and 550 monocotyledons. Half of the monocots (262) are grasses and 118 are sedges. There are more than 100 ferns. No attempt has been made to list the mosses, fungi and lower plants.

"Although the total number of the gymnosperms in the State is not large, they are the most important ecologically and economically. From the economic point of view, the most important species are *Cedrus deodara*, *Pinus excelsa*, *Pinus longifolia*, *Picea smithiana* and *Abies pindrow*."

Probably more botanists have collected in Kashmir than in any other part of India. The first collector was Moorcroft who reached Ladakh in 1820 and sent some specimens to Wallich. Important collectors were V. Jacquemont, Hugh Falconeri, J. F. Royle, T. Thomson, J. E. Winterbottom, Sir Richard Strachey, the Schlagintweit brothers, J. L. Stewart, C. B. Clarke, Inayat, A. Meebold, Keshavanand, Walter Koelz, Prof. W. Troll, R. R. Stewart and G. S. Puri. In spite of all these

collections by eminent botanists, there is a great need of bibliographical and monographic work which needs to be done. The *Flora of British India* is greatly out of date.

Since Hooker's day much Kashmir material has been collected and many monographs have been published especially in the Pflanzenreich of the Berlin Botanical Garden. Some of the more important are the monographs of Pax on the Primulaceae, Schulz on Cruciferae and Wolff on the Umbelliferae. More recently Dr. F. W. Pennell of the Philadelphia Academy of Science has monographed the West Himalayan Scrophulariaceae. Some groups need revision more than others. *Epilobium*, *Geranium*, *Astragalus*, *Oxytropis*, *Artemisia*, *Eriogonum*, *Viola*, the borages, Composites and legumes in general need special attention.

The collections of these botanists are found in the herbarium kept in Kew Gardens, London, and in the continent of Europe and the Indian workers can only refer to

what is in the herbaria at Forest Research Institute, Dehra Dun, or Royal Botanic Gardens, Calcutta. Dr. Stewart's collections are in the Gordon College, Rawalpindi.

The Kashmir Government established the Drug Research Laboratory in 1942 which has done considerable amount of research work on the medicinal and economic plants growing in the State. The Department of Botany of this Institution has also taken up a detailed survey of the flora of Kashmir and a good deal of progress has already been made. Side by side, a herbarium of Kashmir plants is being collected which will be of great practical utility.

A general outline of the Kashmir flora has been given which may interest the systematic botanist. It is hoped that the Institute of Palaeobotany, established by the late eminent scientist, Prof. Sahnii, will continue the work which he started more than a quarter of a century ago.

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EXPLANATION OF PLATE 1

1. *Pyrethrum* flowers ready for harvesting (Tangmarg 7,000 ft.). This plant has been introduced for commercial cultivation in Kashmir.

2. A view of the inner dry valley of Kashmir near Rampur (Rattu). Nanga Parbat in the background.

3. *Atropa acuminata*: It grows wild and is much valued for its medicinal properties.

4. *Digitalis lanata*, a useful medicinal plant grown in forest nurseries.

5. *Phytolacca acinosa* (in fruiting stage): It is commonly used in homoeopathic medicine.



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