

PRELIMINARY OBSERVATIONS ON THE PHYTO-GEOGRAPHICAL CHANGES IN THE KASHMIR VALLEY DURING THE PLEISTOCENE

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ABSTRACT

Four stages in the phyto-geographical evolution of the Kashmir Valley since the early Quaternary period have been distinguished by the author based on his investigations of the fairly complete sequence of fossil floras from the Pir Panjal range.

THE Pleistocene period in India was marked by refrigeration of climate, together with a cycle of orogenic movements, which resulted in the migration and spread of plants to other areas of milder climate. These migratory movements were evolutionary in nature and were in the main controlled by gradual changes in climatic conditions and soil features. Evidences of Pleistocene glaciation are present in Kashmir, Nepal and Eastern Himalayas; but detailed geo-botanical studies of glacial and interglacial deposits have only been done in Kashmir.

The Kashmir Valley was glaciated several times, and deposits of at least three interglacial and four glacial advances have been clearly recognized both from the main Himalayas which bound the valley on the north and the Pir Panjal which lies on its south (DE TERRA & PATERSON, 1939).

Contemporaneously with glaciation, these mountains were uplifted by at least 5,000-6,000 ft. (PURI, 1947); and orogenic movements and glaciation brought about interesting changes in the bio-geography of the valley. A fairly complete sequence of fossil floras has been described by the author (PURI, 1946, 1948) from the Pir Panjal which enables one to distinguish the following stages in the phyto-geographical evolution of this valley.

First Stage—Prior to the glaciation, the northern slopes of the Pir Panjal were forested with an oak-laurel community with little or no conifers (PURI, 1945b, 1949b). This community seems to be similar in physiognomy and composition to oak forests, now growing on escarpments of various mountain ranges of the Himalayas. An example of

such a type has been described recently from Bashahar (PURI, 1952; MOHAN & PURI, 1955). Due to the first glacial advance on the Pir Panjal being mild, as compared to that on the main Himalayas, much of this pre-glacial vegetation seems to have survived and flourished in the valley during the First Interglacial Period. This glacial advance converted the valley of Kashmir into a vast lake—now known by the name of the Karewa lake—the bed of which was later on uplifted and carried up the sides of the adjoining mountains by the late Himalayan orogenies. These lake deposits, called in Kashmiri the Karewas, are for the most part clayey and at higher levels are thickly forested with a mixed conifer-broad-leaved species community. The main conifer growing on the Karewas now is *Pinus wallichii*.

It seems that the Karewa lake was not drained off all at once because the lake deposits at various places seem to belong to more than one interglacial period. They are found at places interbedded with glacial moraines; elsewhere they cover morainic deposits, or are found beneath them. The moraines are now chiefly covered over with forests of *Abies*, which is associated with numerous broad-leaved species in its early development.

The vegetation of the northern slopes of the Pir Panjal during the early Pleistocene comprised an oak-laurel community with *Quercus incana* as the dominant tree. The associated species of this community probably were: *Quercus glauca*, *Machilus duthiei*, *M. odoratissima*, *Litsea chinensis*, *L. lanuginosa*, *Phoebe lanceolata*, *Pittosporum eriocarpum*, *Acer oblongum*, *Buxus papillosa*, *B. wallichiana*, *Mallotus philippinensis*, *Desmodium* spp. *Berberis* sp., *Rosa* sp. The conifers *Cedrus deodara* and *Pinus wallichii* seem to have been very rare in the oak community, since very few fossil specimens of these species have been found in the deposits. As in the Bashahar Himalayas conifers have been seen

entering the oak community only when the latter has been disturbed naturally or artificially, it seems that large-scale invasion of the Himalayas by the conifers must have been a phenomenon of a later time, probably after an intense glaciation and some uplift of the Himalayas had occurred.

Most of the fossil species of this community occur at present in the unglaciated parts of the Himalayas mostly on (southern) scarp slopes of hills, at altitudes varying between 5,000 and 6,000 ft. These are absent from the Kashmir Valley or the Pir Panjal range. The community occupies only well-established soils but in disturbed areas conifers (mostly *Pinus excelsa* and *Cedrus deodara* or *Picea smithiana*) come in, forming a mixed oak-conifer community. Both these communities at present occupy the summer monsoon belt in the Himalayas, where summer temperatures are high with heavy rainfall and the snowfall is scanty during winter. The fossil evidence points out that during the early Pleistocene period the Kashmir Valley was accessible to summer monsoons from south. The adjoining slopes of the Pir Panjal were then lower by at least 5,000-6,000 ft. At that time *Elephas* and *Bos* roamed in these forests (DE TERRA & PATERSON, 1939).

Second Stage — At the close of the First Interglacial Period, the geography of the valley passed through further changes both climatically and in soil conditions. The Pir Panjal was uplifted by a few thousand feet, the Karewa lake was partly drained off; and the lake beds were dragged up the mountainsides, covering beneath them the older soil and rock types. The valley became partially inaccessible to summer monsoons as a result of the uplift of the Pir Panjal, and its climate changed from, what may be called, tropical to subtropical and even somewhat temperate. The fossil plants belonging to this period are characteristic of altitudes of 7,000-8,000 ft. of the Himalayas and some of the species now occur even at 9,000 ft. The fossil vegetation consisted of: *Quercus semecarpifolia*, *Q. dilatata*, *Q. ilex*, *Aesculus indica*, *Litsea* sp., *Desmodium latifolium*, *Desmodium* spp., *Rubus fruticosus*, *Acer caesium*, *Acer pictum*, *Acer* sp., *Pinus wallichii*, *Cedrus deodara*, *Picea smithiana*, *Abies webbiana*, etc. (PURI, 1945b, 1945d).

Of the dominant components of this mixed oak-conifer-broad-leaved species community, the oaks do not occur today in the

Kashmir Valley. However, the various broad-leaved species and conifers form an integral part of the vegetation of the valley and its adjoining mountains now.

Third Stage — Towards the close of the Second Interglacial Period, the phyto-geography of the Kashmir Valley underwent further changes and the features similar to what are found at the present time began to take shape. The valley was drained off the Karewa lake and the mountains had by then attained somewhat their present elevations; thus closing the valley to summer monsoons and bestowing on their tops more snows. The nature and old topography and soils of the early periods were destroyed, giving place to immature soils and new topography. This new topography was characterized by having tops with shallow soils; slopes and valley bottoms with soils formed of glacial deposits (gravels, detritus and morainic material) and the lake deposits. All these soils being newly laid and re-assorted were more fertile. As a result of these changed ecological conditions, the vegetation of this period became dominated by conifers (mainly *Abies* and *Pinus*), and broad-leaved species of *Juglans regia*, *Populus ciliata*, *P. nigra*, *Populus* sp., *Salix wallichiana*, *S. denticulata*, *Salix* spp., *Aesculus indica*, *Prunus cornuta*, *Prunus cerasioides*, *Pyrus communis*, *Pyrus* spp., *Rose* sp., *Desmodium* sp., *Acer caesium*, *Acer* spp., *Carpinus* sp., *Betula* sp. etc. (PURI, 1945a, 1945c, 1945d, 1951).

This vegetation of mixed conifer-broad-leaved plants occurs at the present time in the valley on the northern slopes of the Pir Panjal between the altitudes of 8,000 and 10,000 ft. and some of the plants may ascend to 11,000 ft.

Fourth Stage — The present vegetation of the Kashmir Valley and of the northern slopes of the Pir Panjal range is very much like the late Pleistocene vegetation sketched in the third stage above. The Karewa deposits are dominated by *Pinus excelsa* community, with poplars, cherries, willows, some maples, etc. On the glacial moraines, *Abies webbiana* community, mixed with broad-leaved trees of similar species, is predominant.

Where the underlying rocks have come on the surface by erosion of the glacial moraines or the Karewa lake beds, the vegetation comprises stunted trees of *Abies webbiana*, birches, dwarf junipers, willows, *Rhododendron campanulatum* and small bushes

of herbaceous species (PURI, 1947, 1948, 1949a).

The present configuration of the Kashmir Valley thus dates back to the late Pleistocene period and evolution of its phyto-geography since the early Pleistocene has mainly been directed to cover the original monsoonic area into a non-monsoonic valley with a somewhat temperate climate in a tropical region. The changes in the soil, geology and topography were brought about by the glaciation and the orogenic movements of the Hima-

layas. The reconstruction of the progressive changes in the phyto-geographic evolution has been made possible by the study of macro-fossils discovered from these deposits. The work is, however, by no means complete and a study of the rich microflora embedded in these Karewa deposits would repay with very interesting results on the phyto-geography of this area.

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