AN OUTLINE OF THE VEGETATIONAL ACCOUNT OF THE NORTH-WESTERN HIMALAYAS.

India is a tropical country with the Tropic of Cancer passing right through its median and its southern end, thus, lies very close to the Equator. The climate of the Indian sub-continent is greatly influenced by the Indian Ocean in its south and the great Himalayas in its north, extending from east to west. The well-known phenomenon of latitudinal differences in vegetation witnessed in Europe and America is not visible in India (Puri 1960:93). The natural vegetation of India, in response to marked climatic variations and edaphic diversities, is rich and variegated. Champion (1936) published the first comprehensive classification of Indian vegetation. Puri (1960) followed more or less the same pattern, although he pleaded for its revision. Champion and Seth (1968) classified the Indian forests into sixteen types and each is further split into several sub-types.

India has been divided into various floristic regions by different workers from time to time: Clarke (1898) divided it into 11; Hooker (1907) into 9; Chatterjee (1939) into 10; and Puri (1960) into 10. Champion and Seth (1968), however, recognised only nine floristic regions. In the Western Himalayas (considered here as the North-Western Himalayas) is one of these and differs from the Eastern Himalayas in the greater representation of conifers. While the European element is conspicuous in the former, the Malayan, Chinese and Burmese are prominent in the latter. The present study on
the leafy liverworts is based mainly on the collections made exclusively from the N.W. Himalayas. This floristic region is about 800 km long and about 200-240 km wide and covers the states of Jammu and Kashmir (J&K), Himachal Pradesh (H.P), Union Territory of Chandigarh (U.T.), mountainous parts of Uttar Pradesh (U.P.), submountainous parts of Punjab and Haryana states and Nepal. Geographically this region lies between 29°-35°N latitude and 74°-86°E longitude.

The type of vegetation in a particular region depends largely on the climate, the soil and the past treatment. Rainfall and temperature, in addition to wind and topography, are the most obvious factors of climate. The rainfall in India is largely monsoonic and the total annual rainfall is an important factor in determining the nature of vegetation. The average annual rainfall in this region (N.W. Himalayas) is 1020-2050 mm. The interior regions receive less monsoon rainfall but heavy snowfall. Thus, there is a considerable variation between the climates of outer and inner ranges. In general the rainfall is maximum in the eastern parts of the N.W. Himalayas (Nainital), which receive the bulk of the monsoon winds, but it goes on decreasing as these winds move westward. In addition to the direction of the monsoon, some other factors like altitude, location, and the direction of mountain ranges play an important part in the distribution of rainfall. Thus Dharamsala (H.P.), though it is on the western side, receives
the maximum rainfall up to 3200 mm annually - because of the direction and location of the mountains. The distribution of rainfall is quite uneven and varies from 600-3200 mm annually. Of the total annual rainfall, 75% falls during the rainy months of July to September. The vegetational zonation is governed by monsoon and follows other South-East Asian countries like South-East China, Indonesia and Japan, although factors like soil, physiography, topography and biotic have a role in governing the flora of any specific areas.

Snow falls during the winter months above 1500 m and may remain for few days to months depending on the altitude and location of the area. At elevations of 3000 m the average snowfall is about 300 cm and lasts from December to March while places above 4500 m remain perpetually under snow.

Temperature is the most obvious factor of climate. The mean annual temperature exceeds 24°C over the whole country with the exception of the hill areas and the extreme north-west. Champion and Seth (1968) divided India into four zones on the primary basis of temperature as follows:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Mean annual temperature</th>
<th>Mean January Temperature</th>
<th>Winter Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Tropical</td>
<td>Over 24°C</td>
<td>Over 18°C</td>
<td>None; no frost</td>
</tr>
<tr>
<td>II. Subtropical</td>
<td>17-24°C</td>
<td>10-18°C</td>
<td>Definite but not severe; frost rare.</td>
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<tr>
<td>III. Temperate</td>
<td>7-17°C</td>
<td>-1-10°C</td>
<td>Pronounced, with frost and some snow.</td>
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<tr>
<td>IV. Alpine</td>
<td>Under 7°C</td>
<td>Under -1°C</td>
<td>Severe, with much snow.</td>
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</table>
These zones are not very strict and are greatly influenced by altitude, rainfall, edaphic and other ecological factors. The variations in altitude play a significant role in the determination of temperature and distribution of rain. Miller (1950), while discussing the effect of altitude on climate, states "height above sea level has a pronounced influence on climate, in many respects limiting the effects of increased latitudes" and this is in conformity with the earlier generalization of Humboldt (1817) who found a correlation between the altitude and latitude and stated that the successive altitudinal zones of vegetation correspond to the latitudinal zones from the Equator to the poles and that an elevation of above 100 m on a tropical mountain would make a difference of 1° latitude. Puri (1960) pointed out that the rate of decrease of temperature with elevation at the time of maximum day temperature in the month of January averages 3°F per 1000 ft. (304 m), while the rate of decrease of temperature with elevations at night or at the time of minimum temperature averages 1°F per 1000 ft (304 m) in the western Himalayas. The wide range of altitude, temperature and rainfall result in a diversified forest flora in this region. Mehra et al. (1971) gave a floristic account of some forest types of this region. They divided the N.W. Himalayas into four climatic zones as given below:

1. Tropical
   In the foot-hills, the Siwaliks and up to 1,000 m in the outer Himalayan ranges.
2. Subtropical 1,000-1,800 m
3. Temperate 1,800-8,600 m
4. Alpine Above 3,600 m

The forests do not extend beyond 3,600 m. The author has adopted these climatic zones to discuss the vegetation of this region.

**Tropical zone**

This zone comprises the plains and the adjoining foothills which may ascend up to 1000 m above mean sea level (m.s.l.) in the Siwaliks and outer ranges of the H.W. Himalayas. It includes the area around Jammu, Pathankot, Dunera, Chandigarh, Kalka, Dehra Dun and Naldwani. There are mainly two types of tropical forests that occur in this zone, viz. Tropical moist deciduous forests and Tropical dry deciduous forests. Tropical moist deciduous forests occur in the areas where annual rainfall is between 1500-1800 mm, the maximum temperature is 44°C and the minimum 1.8°C. In this type, two subtypes can be distinguished: Moist Sal-bearing forest (Shorea robusta) and Moist mixed deciduous forest. In the former, 'sal' (Shorea robusta) is a dominant species and occurs in almost pure formation around Dehra Dun (Lachhiwala forest range), Nainital (Ramibag). On its upper limit and on the northern aspects Ficus roxburghii often occurs.

The areas with less rainfall and less relative humidity develop tropical dry deciduous forests. The areas around Chandigarh, Kalka, Pathankot, Dunera and Jammu possess
such type of forests. The common trees are: **Bombax ceiba**, **Acacia catechu**, **A. arabica**, **A. leucophloca**, **A. modesta**, **Pyrus pashia**, **Cassia fistula**, **Zizyphus jujuba**, **Dalbergia sissoo**, **Manisfera indica** etc. Common shrubs are: **woodfordia fruticulosa**, **Adhatoda vasica**, **Euphorbia royleana**, **Lantana camara**, **Capparis decidua** and **Zizyphus numularia**.

**Subtropical Zone**

This is an intermediate zone between the tropical and montane-temperate zones and extends from 1000–1800 m above m.s.l. The average annual rainfall varies from 900–2500 mm. Summer months are generally hot with maximum temperature up to 38°C, while the winter is moderately cold. Snow falls only for a few days in mid-winter and that too in upper limits. This zone comprises "montane subtropical forests". The vegetation is a mixture of tropical and temperate species.

Typically, **Pinus roxburghii** forms pure crops which are never dense. On moist places, scattered broad-leaved evergreen trees occur. At the upper limit **Quercus incana** is the most typical associate along with **Rhododendron arboreum** and **Lyonia ovalifolia**.

**Temperate Zone**

The montane temperate zone extends from 1800–2600 m above m.s.l. in this region. The annual rainfall varies considerably and ranges from 1000–3000 mm. The climate is cold in winter with minimum temperature reaching up to -10°C.
and it is moderately hot in summer with maximum temperature up to 32°C. The snowfall is moderately and occurs during the months December to March. This zone comprises "monsoon montane temperate forests" and these are not comparable with the true temperate forests of Northern Hemisphere, because the climate is not typically humid as is found in the true temperate forests. The montane temperate zone can be further divided into lower, middle and upper zones.

The lower temperate zone forests overlap the subtropical zone forests. *Quercus incana* is a dominant species and occupies the lowest zone of the temperate belt. The middle temperate zone has mixed Oak-oak forests. *Quercus dilatata* is a dominant species. In the upper temperate zone, the mixed coniferous forests comprising *Abies pindrow* and *Picea smithiana* with scattered *Cedrus deodara* and *Taxus baccata* are predominant.

**Alpine zone**

This zone extends above 3600 m. above m.s.l. The snow-fall is very heavy, the winter is severe and the summer is short. The rainy period is only during the summer months, July to September. The vegetation in this zone is 'Alpine' stony deserts', 'Alpine scrubs', 'Alpine meadows' and 'Alpine forests'. These extend from 3000 m to the snow line. The vegetation is bushy in habit with short and much branched stems. Typically, alpine plants are spreading and appear like a carpet on the ground.

The following places in the N.W. Himalayas were visited during the course of present study. Various localities
with more or less same type of vegetation and having geographical continuity have been grouped together under one heading. The main station is the one which is written first and the smaller and less known places around the main station are put within parentheses. The altitude, type of forest and climate zone is also noted against each.

I. **Himachal Pradesh State (H.P.)**

<p>| 1. Dalhousie | 2042 m | (Banikhet, Baloon, Lover's Walk, Bakrota hill, Panjpulla, Jandrighat) 1500-2100 m. Predominantly angiospermic at places mixed forests. At some places there are pure formation of Cedrus deodara. Subtropical to temperate zone |
| 2. Khajjiar | 1600 m | (Lakkarmandi, Kalatope,) 1600-2400 m. Predominantly coniferous (pure or mixed) forests Temperate zone. |
| 3. Chamba | 1400 m | (Sara, Thali,) 1400-2000 m. Lower reaches with predomiley angiospermic, higher reaches with mixed forests. Subtropical zone. |
| 4. Dharamsala | 1400 m | (Haleod Ganj, Forsyth Ganj) 1200-2700 m. Predominantly angiospermic (Oak) sometimes mixed with Pinus roxburghii or Cedrus deodara. At some places there are pure formation of Quercus incana. Subtropical to temperate zone |
| 5. Kulu | 1500 m | (Jari, Kasole, Manikaran, Pulga, Ranongri, Parvati Valley) 1500-2500 m. Angiospermic at lower reaches, mixed at higher altitudes. Subtropical to temperate zone. |</p>
<table>
<thead>
<tr>
<th>6. Manali</th>
<th>1800 m</th>
<th>(Naggar, Jagat Sukh, Kothi) 1500-3578 m. Pure <em>Cedrus deodara</em> or mixed coniferous and mixed forests. Temperate to alpine zone.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Kasauli</td>
<td>1800 m</td>
<td>(Dharampur, Solan), 1530-1800 m. Mixed forests, subtropical to temperate zone.</td>
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<tr>
<td>8. Simla</td>
<td>2202 m</td>
<td>(Summer hill, Jakhoo hill, Jubbal, Mashobra, Sanjouli,) 1800-2500 m. Mixed forests, mostly coniferous at higher altitudes. Subtropical to temperate zone.</td>
</tr>
<tr>
<td>9. Narkanda</td>
<td>2700 m</td>
<td>(Shillaro, Hattoo mountain, Baghi, Tutupani, Khadrala), 2700-3500 m. Mixed forests or mixed coniferous. At places pure Oak formation (Hattoo mountain) or pure <em>Cedrus</em> formation (Shillaro). Temperate forests to alpine meadows.</td>
</tr>
</tbody>
</table>

**II. Uttar Pradesh (U.P.)**

<table>
<thead>
<tr>
<th>1. Dehra Dun</th>
<th>682 m</th>
<th>(Lachhiwala forest range, Rishikesh side) 500-682 m. Angiospermic, predominantly 'sal' forests. Tropical moist deciduous forests.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Mussoorie</td>
<td>2100 m</td>
<td>(Municipal Garden, Jabber Khet, Lal Liba, Chakrata, Balaroo Khud, Sarkunda, Mossy Fall, Dhobi Khad, Spring Road, Depot Road, Camel's back road, Chakrata toll, Kempty falls) 1700-2400 m. Mixed forests At places there are pure formations of <em>Juniperus incana</em>. Temperate zone.</td>
</tr>
</tbody>
</table>
3. Nainital 1981 m (Tiffon's top (Dorothy's seat), Naina Peak, Luria, Kanta, Naukuchiatal, Tanki, Kilbury, Sat Tal, Bhim Tal), 1400-2400 m. Predominantly angiospermic with Oak as a dominant tree, at places pure formations of Cedrus deodara (Naina Peak and Kilbury), at lower altitudes (Sat Tal) Lantana indica is mostly predominant. Subtropical to temperate zone.

4. Ranikhet 1850 m (Kalika), 1850-1900 m. Mixed forests, at places pure formation of Cedrus deodara, and Pinus roxburghia. Temperate zone.

5. Almora 1615 m Mixed forests. Subtropical zone.