# FLORA OF GREAT HIMALAYAN NATIONAL PARK

S. K. Singh & G. S. Rawat

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## HIMACHAL PRADESH

Flora of Great Himalayan National Park Himachal Pradesh







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# FOREWORD

The Great Himalayan National Park (GHNP) and adjacent sanctuaries in Kullu district of Himachal Pradesh (HP) encompass a rich array of floral and faunal assemblages including some of the highly endangered species. The region is also well known for its aesthetic, cultural, hydrological, and other intrinsic values. The Government of HP is committed to safeguard the ecological integrity and conservation of biodiversity in the region while meeting bonafide biomass needs of the local people. Recent project on the Conservation of Biodiversity aided by the International Development Agency of the World Bank has resulted in formulation of the long term conservation plans for the area which have suggested strong component of eco-development programmes for the local people. A large number of individuals and institutions have collaborated with the HP Forest Department in this project during past five years. Contribution of the Wildlife Institute of India (WII) Dehra Dun in assessing the biodiversity and local peoples' biomass needs in the area has been particularly significant.

I am extremely happy that Drs. S.K. Singh and G.S. Rawat from WII have brought out a comprehensive Flora on GHNP based on their extensive surveys in the region. The book contains valuable information on the identity, distribution and local use of flowering plants (including medicinal herbs) found in and around GHNP. The document would be of immense use to the field biologists, foresters, protected area managers and even amateur nature enthusiasts. It is hoped that they would be enthused to take up further research and monitoring activities in the area to strengthen the conservation of our rich biological heritage.

11.4.2000

Shimla
April 11, 2000

**(S.K. Pande)**
*Principal Chief Conservator of Forests*
*Himachal Pradesh*

# PREFACE

The upper catchments of Tirthan, Sainj and Parvati rivers in Kullu district of Himachal Pradesh (HP) have remained relatively less traversed by the plant explorers compared to the adjacent Shimla and Lahaul – Spiti districts. The area came into limelight after the initial notification of Great Himalayan National Park (GHNP) in 1984 based on its conservation significance. A large number of local people who have been living in the lower fringes of the park staked their rights on the natural resources of the park i.e. pastures for livestock grazing, commercially important medicinal herbs and mushrooms. This necessitated an integrated multidisciplinary study on the biodiversity of the park and local people's dependency on it. Such a study was initiated by the Wildlife Institute of India (WII) with a strong focus on the eco-development in the year 1995. The study was conducted in collaboration with the HP Forest Department aided by the World Bank under Forestry Research Education and Extension Project (FREEP) of the Government of India. The final reports on the project have already been submitted to both the Government of India and the HP state Government for further conservation planning. This volume is one of the outcomes of FREEP project in GHNP. It contains systematic treatment of vascular plants (Angiosperms and Gymnosperms) recorded by us in and around GHNP along with their local names, local use and distribution within the park. It is hoped that the protected area managers, plant ecologists and naturalists working in the area would find this flora useful.

We are extremely grateful to Shri S.K. Pande, Principal Chief Conservator of Forests, HP who has kindly written the foreword for this volume. Our special thanks are due to Shri Sanjeeva Pandey (Director, GHNP) for encouraging us to take up this work and providing necessary logistic support during our fieldwork in GHNP. We are also thankful to various officials of HP Forest Department viz., former and present Chief Wildlife Wardens, Shri Vinay Tandon (Chief Conservator of Forest), Shri Nagesh K. Guleria (former Director of GHNP), Shri P. Chowdhary (Dy. Director GHNP), and all the field staff of GHNP for their help and cooperation.

We record our grateful thanks to Shri S.K. Mukherjee, Director WII for his constant encouragements and support. We are indebted to Shri B.P. Uniyal of the Botanical Survey of India (BSI) Northern Circle - Dehra Dun and Dr. P.K. Hajra, ex-Director BSI for their valuable suggestions

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# GENERAL INTRODUCTION

The North west Himalaya has long been recognized as a distinct floristic region in India (Hooker 1906, Mani 1974). Owing to varied topography, wide altitudinal range and unique geographical location, this region harbours a rich flora and exhibits affinities with the Mediterranean, Siberian, Tibetan and Indo-Malayan regions. Palaeobotanical evidences indicate that many of the woody elements in the flora of Himalayan region owe their origin from the tropical wet evergreen forests of the Indian peninsula (Vishnu-Mittre 1984). Orogenic changes subsequent to the final phase of Himalayan upliftment and Pleistocene glaciation influenced the Himalayan flora to a great extent. While creation of new corridors and land bridges facilitated the migration of flora and fauna from the adjoining areas, some biogeographic barriers and resultant isolation of certain populations promoted endemism in many taxa resulting in the evolution of several ecotypes, subspecies and species. Perhaps, this region has experienced much more changes in its bioclimates during the recent geological past than any other part of India. These changes, coupled with more recent anthropogenic pressures, have shaped the present flora of the region.

According to the early phytogeographers *viz.*, Clarke (1898) and Hooker (1906) the entire north west India, west of Sharda river constituted one floristic region *i.e.* western Himalaya which includes Jammu and Kashmir, Himachal Pradesh and hills of Uttar Pradesh. The typical families of this region are Asteraceae, Rosaceae, Poaceae, Ranunculaceae, Scrophulariaceae and Brassicaceae (Rau 1975). The characteristic genera include *Aster*, *Berberis*, *Impatiens*, *Potentilla*, *Primula*, *Saussurea*, *Ranunculus* and *Strobilanthus*.

Although, various sectors within the western Himalaya (*i.e.* north western, western and trans-Himalaya) show a striking resemblance in their flora, there is a considerable variation in the floristic structure and diversity within these zones. Several areas have remained unexplored floristically. The Great Himalayan National Park (GHNP) is one such area in Himachal Pradesh, which remained under-explored in terms of its flora. This work is an outcome of 4 years of systematic plant collection and documentation of species from this park.

## Fig. 1 Study Area - Great Himalayan National Park , Himachal Pradesh

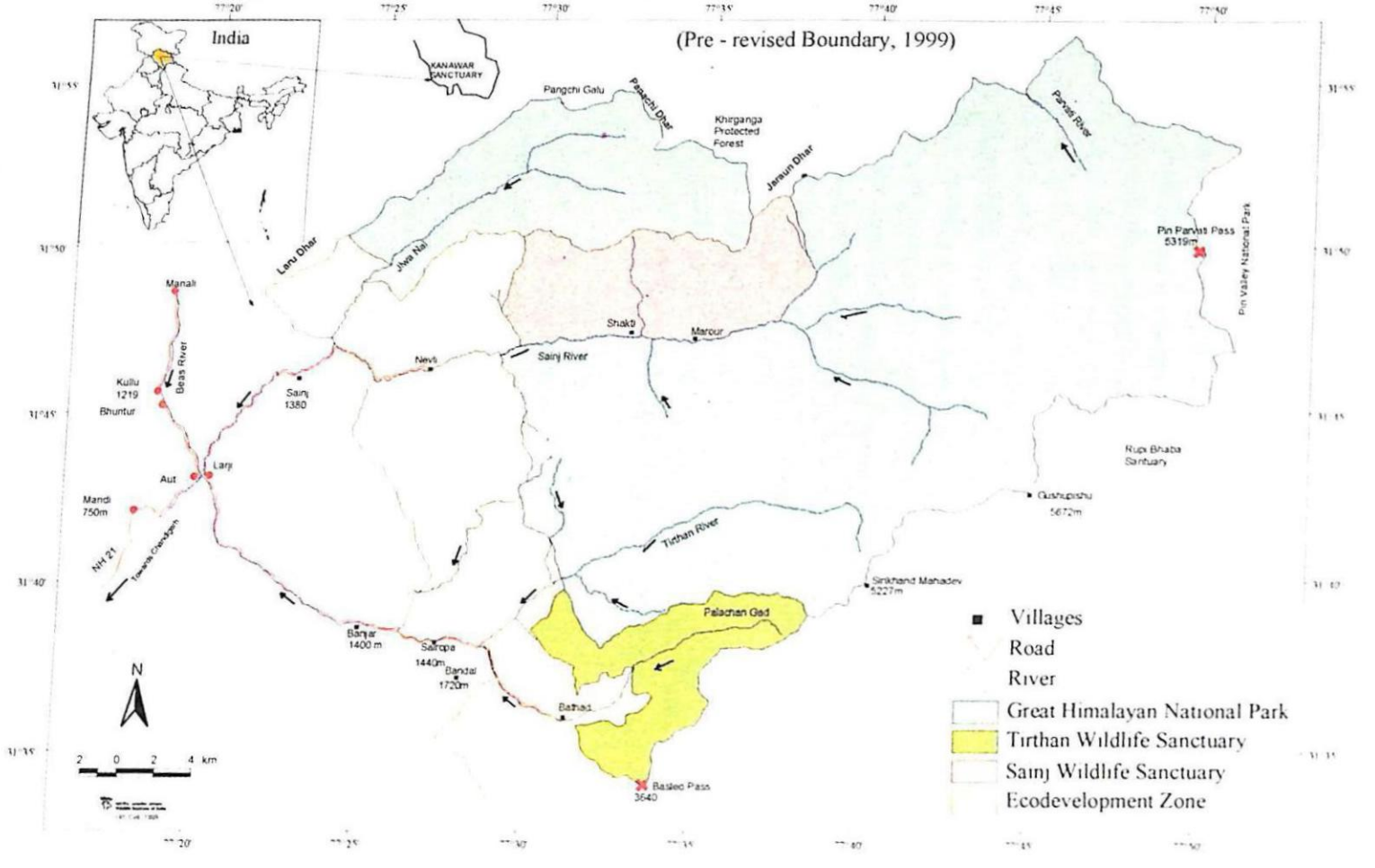



Fig. 1. Base map of Great Himalayan National Park

## The Great Himalayan National Park: Physical and Biological Attributes

### *Location*

The Great Himalayan National Park (GHNP) and adjacent conservation areas located in Kullu district of Himachal Pradesh, encompass nearly 1171 $km^2$ area and lies between $31^0$ 38' 28" N to $31^0$ 51' 58" N latitude and $77^0$ 20" 11" E to $77^0$ 45' 52" E longitude. The Park is well known for its rich floral and faunal diversity, important habitat for a large number of rare and threatened species representing the North-western Himalayan biotic province 2A (Gaston *et al.* 1981, Rodgers and Panwar 1988). It is one of the two National Parks in the world to support the population of endangered western tragopan (*Tragopan melanocephalus*) and a large number of rare and threatened plant species, many of which are of medicinal value. The Park is bounded by Rupi Baba Wildlife Sanctuary in the east, Pin Valley National Park in the north east and Kunawar WLS in the north west. However, the south western fringe of the Park is surrounded by a heavy human habitation, cultivation and orchards. GHNP, along with adjoining protected areas form a large, relatively undisturbed and contiguous area having great potential for long term conservation of natural resources including native flora and fauna. This park covers the catchment areas of Jiwanal, Sainj, Parvati and Tirthan rivers which are tributaries of Beas river. Tirthan and Sainj rivers flow in the east-west direction and criss-cross through the deep gorges. The western fringe of the Park is approachable by road from Aut near Kullu but there are no motorable roads inside the Park. The Park headquarter is located at Shamshi, near Kullu air port. The study area is shown in Fig. 1.

### *Topography*

GHNP is characterised by deep river valleys and steep mountain slopes with an altitudinal range of 1344 m (near Seund at the confluence of Jiwanal and Sainj river) to 6248 m (an unnamed peak in Khirganga Protected Forest) in the east of Mathan Dhar. The distribution of area under different altitudinal zones and slope categories are shown in Table 1 and 2 respectively. Nearly 50% of the area lies between the altitudinal range of 4000-5600 m. The slope-wise distribution of the area shows that more than 50% of the area lies between the slope category of 27°-45°.

**Table 1.** Area under different altitudinal zones within GHNP and adjacent areas (Source: Negi,1996)

| Name of area | Altitudinal zone (m) wise area in ha. | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | <1600 | 1600-2400 | 2400-3200 | 3200-4000 | 4000-4800 | 4800-5600 | 5600-6400 | |
| GHNP | - | 1149 | 8363 | 12743 | 29647 | 24134 | 464 | 76500 |
| Sainj Sanctuary | - | 235 | 2723 | 3068 | 2518 | 456 | - | 9000 |
| Tirthan Sanctuary | - | 80 | 2135 | 2900 | 985 | - | - | 6100 |
| Ecodev. Area | 505 | 8394 | 13474 | 3083 | 44 | - | - | 25500 |
| Total | 505(0.4) | 9858(8.4) | 26695(22.8) | 21794(18.6) | 33194(28.4) | 24590(21.0) | 464(0.4) | 117100 |

**Table 2.** Area under different slope classes in GHNP and adjacent areas (source: Negi, 1996)

| Name of area | Slope wise distribution of area In ha. | | | | |
|---|---|---|---|---|---|
| | < 33% (<19$^{O}$) | 33-50% (19-27$^{O}$) | 50-100% (27-45$^{O}$) | >100% (>45$^{O}$) | Total area (ha.) |
| GHNP | 23469 | 12225 | 35252 | 5554 | 76500 |
| Sainj Sanctuary | 112 | 1197 | 7372 | 319 | 9000 |
| Tirthan Sanctuary | 232 | 713 | 5060 | 95 | 6100 |
| Ecodev. Area | 1127 | 4524 | 19552 | 297 | 25500 |
| TOTAL | 24940(21.3) | 18659(15.9) | 67236(57.4) | 6265(5.4) | 117100 |

The terrain is characterised by numerous high ridges, deep gorges and precipitous cliffs, rocky crages, glaciers and narrow valleys. The eastern part of the Park is perpetually snow bound. Pleistocene glaciation has greatly influenced the topography of the region and has left extensive moraines, river terraces and hanging valleys (Gaston and Garson 1993).

The topography of the area has also been influenced by avalanches and landslides. Avalanches occur frequently after heavy snow, often originating from steep southern aspect especially during April to June. Landslides are common features during rainy season.

***Geology and soil***

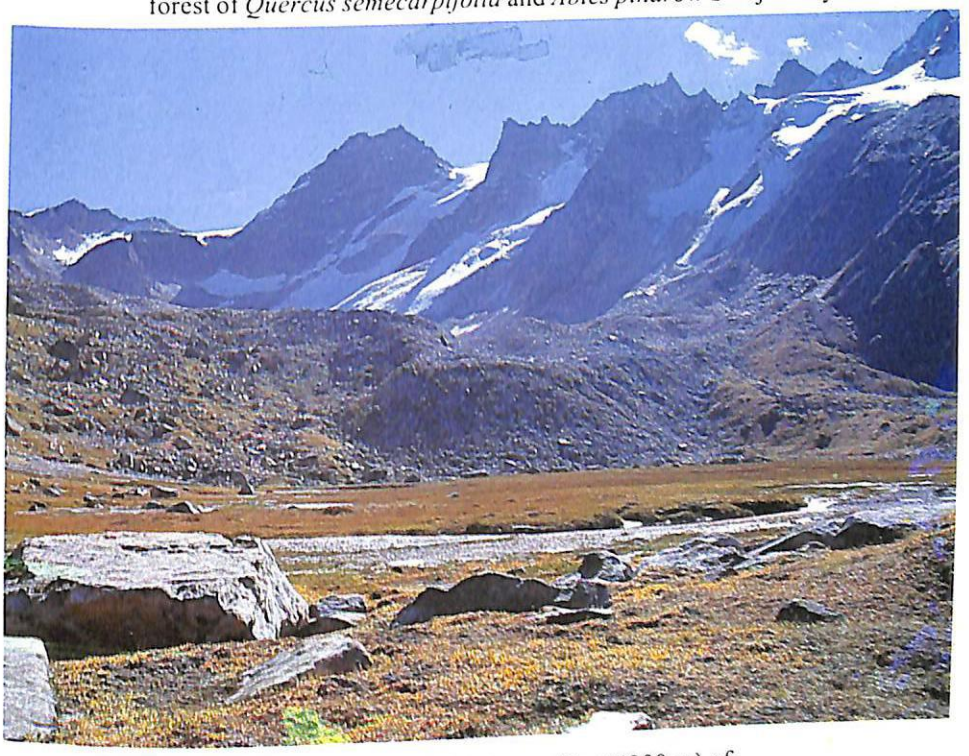
Geologically, the Western Himalaya is divisible into three series *viz.* the northern, central and southern. The northern range that includes Kullu and adjoining areas is known as Tibetan zone (Wadia 1957). The geology, rock and soil affect the vegetation of a place by influencing the moisture regime, structure, texture and drainage pattern. The underlying rocks found in the area are largely quartzite, schist, phyllite, dolomites, limestone, shale, slate, gneiss and granites (Anonymous 1987). Limestone is found at Larji and extends up to Rakti in the Sainj valley. The quartzite is found in the Parvati valley below Manikaran. The Beas valley is dominated by gneiss and schist, which disintegrate into loam or clay and is marked by the absence of quartzite (Sharma 1987). These formations have given rise to sandy, alluvial and podsolic soils.

In order to get detailed soil characteristics for this area the senior author collected 10 samples each of surface soil from various altitudinal zones covering a depth of 0-10 cm. Fresh samples were weighed, oven dried at 105° C for 24 hours and weight differences were noted to determine soil moisture content. The values obtained for different stands were averaged for each forest type. All the samples for each forest type in different altitudinal zone were mixed in order to form a composite sample. The pH was measured with the help of pH meter and soil temperature by soil thermometer, inserting to a depth of 5 cm during May to October 1997. The values were averaged for each zone (Table 3). In general, soil pH was 6.05 ± 0.90. The highest pH of 8.22 was recorded from temperate forest near camping site and lowest pH of 4.16 from alpine area of Tirth in the Tirthan valley.

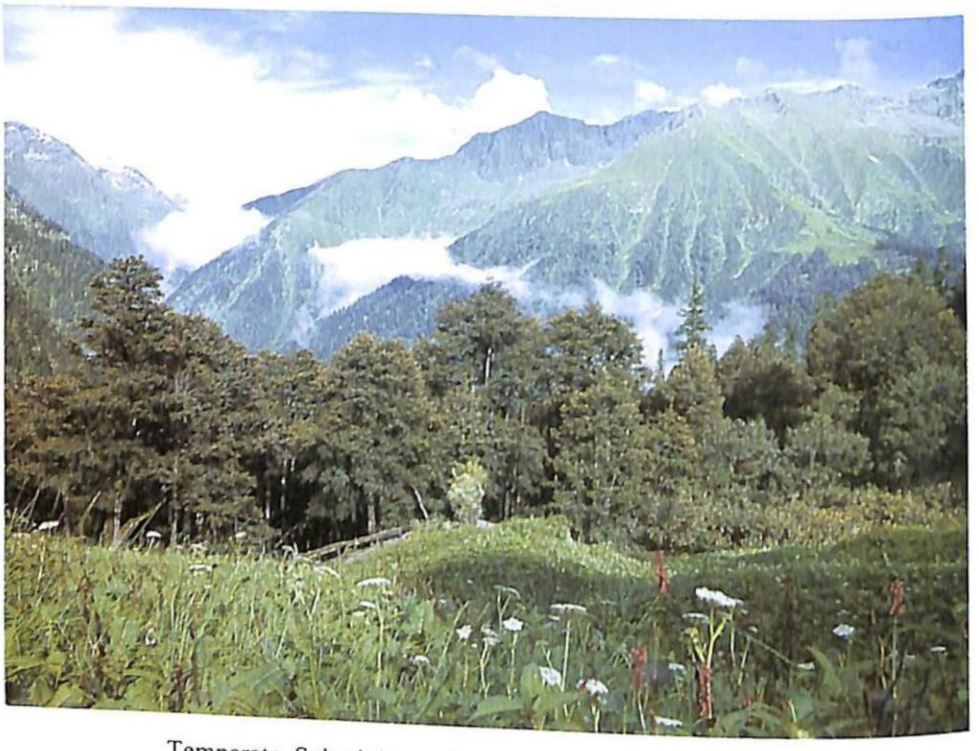
**Table 3.** Soil parameters in various altitudinal zones

| Altitudinal zone | pH | Soil Temperature | Soil moisture | Organic Matter | Ca | Mg | S |
|---|---|---|---|---|---|---|---|
| | | °C | | % | | | |
| Lower Temperate | 6.24±0.82 | 15.8±3.7 | 21.5±3.8 | 68.6±10.5 | 0.05±0.02 | 0.004 | 0.15 |
| Mid Temperate | 6.15±0.42 | 12.6±3.1 | 25.3±5.3 | 71.0±12.1 | 0.12±0.03 | 0.005 | 0.24 |
| Upper temperate | 6.18±0.50 | 9.3±2.1 | 37.8±6.1 | 65.5±11.5 | 0.12±0.02 | 0.008 | 0.16 |
| Subalpine | 5.95±0.18 | 5.4±2.0 | 45.2±5.5 | 62.8±9.4 | 0.25±0.02 | 0.010 | 0.13 |
| Alpine | 5.52±0.34 | 3.6±2.2 | 43.8±7.3 | 64.7±10.2 | 0.04±0.2 | 0.007 | 0.27 |

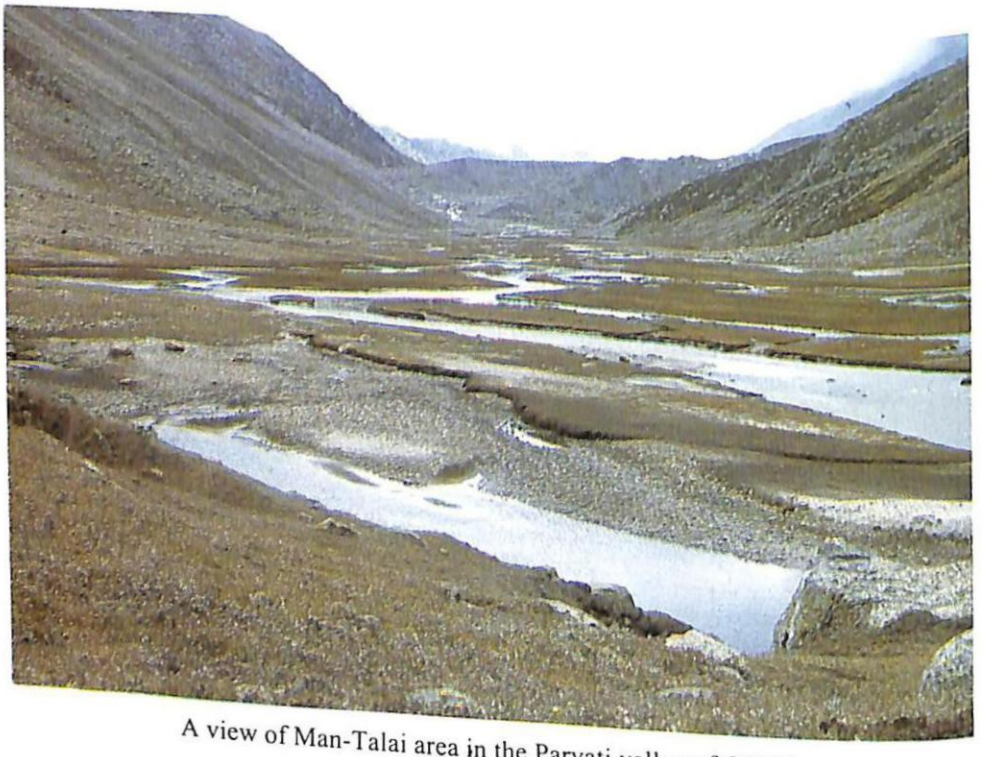
Alpine meadow at Dhela 'Thach' (3300-3700m) intermingling with sub-alpine forest of *Quercus semecarpifolia* and *Abies pindrow* Sainj valley



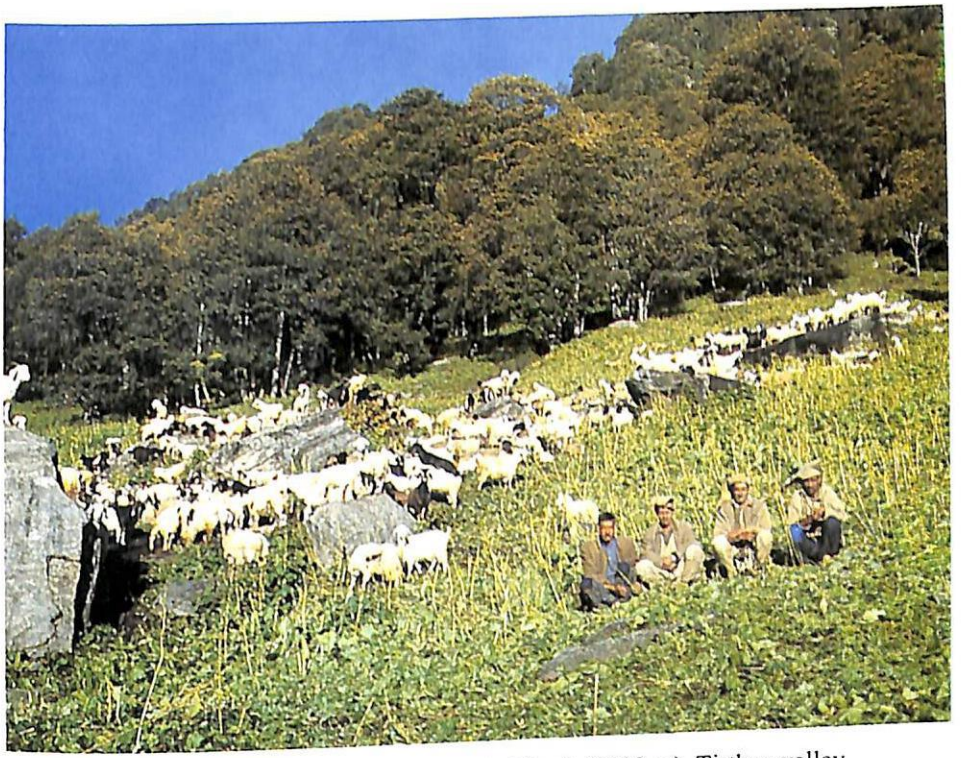
Alpine meadows in Tirthan valley (4200 m) of GHNP dominated by *Phleum alpinum*



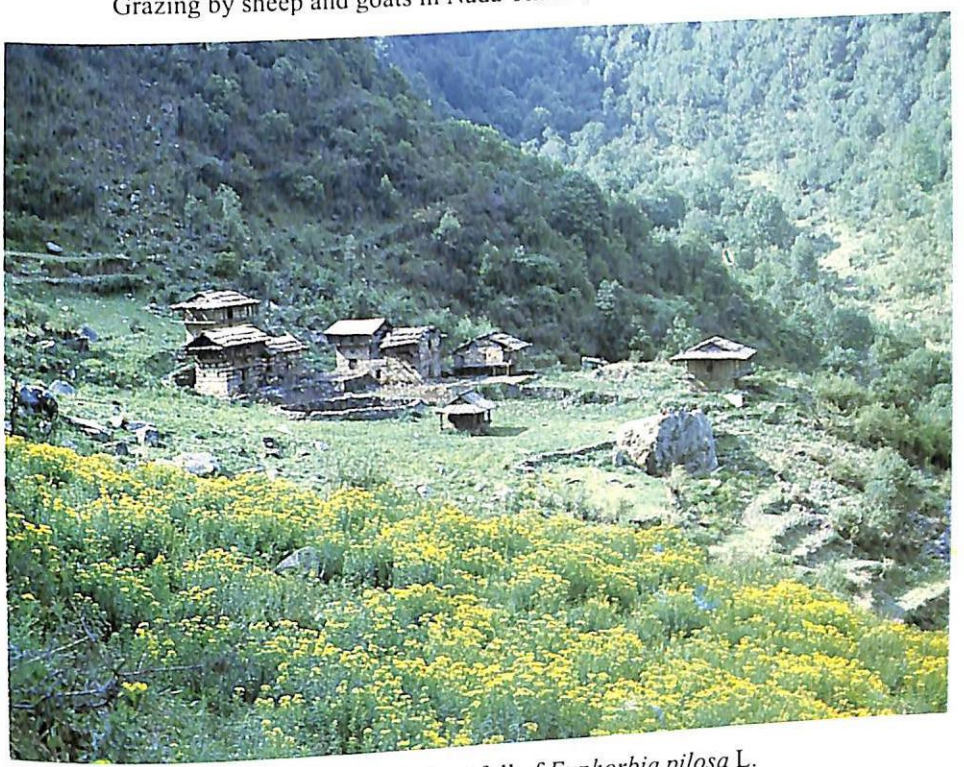
Temperate, Sub-alpine and Alpine zones of Tirthan valley



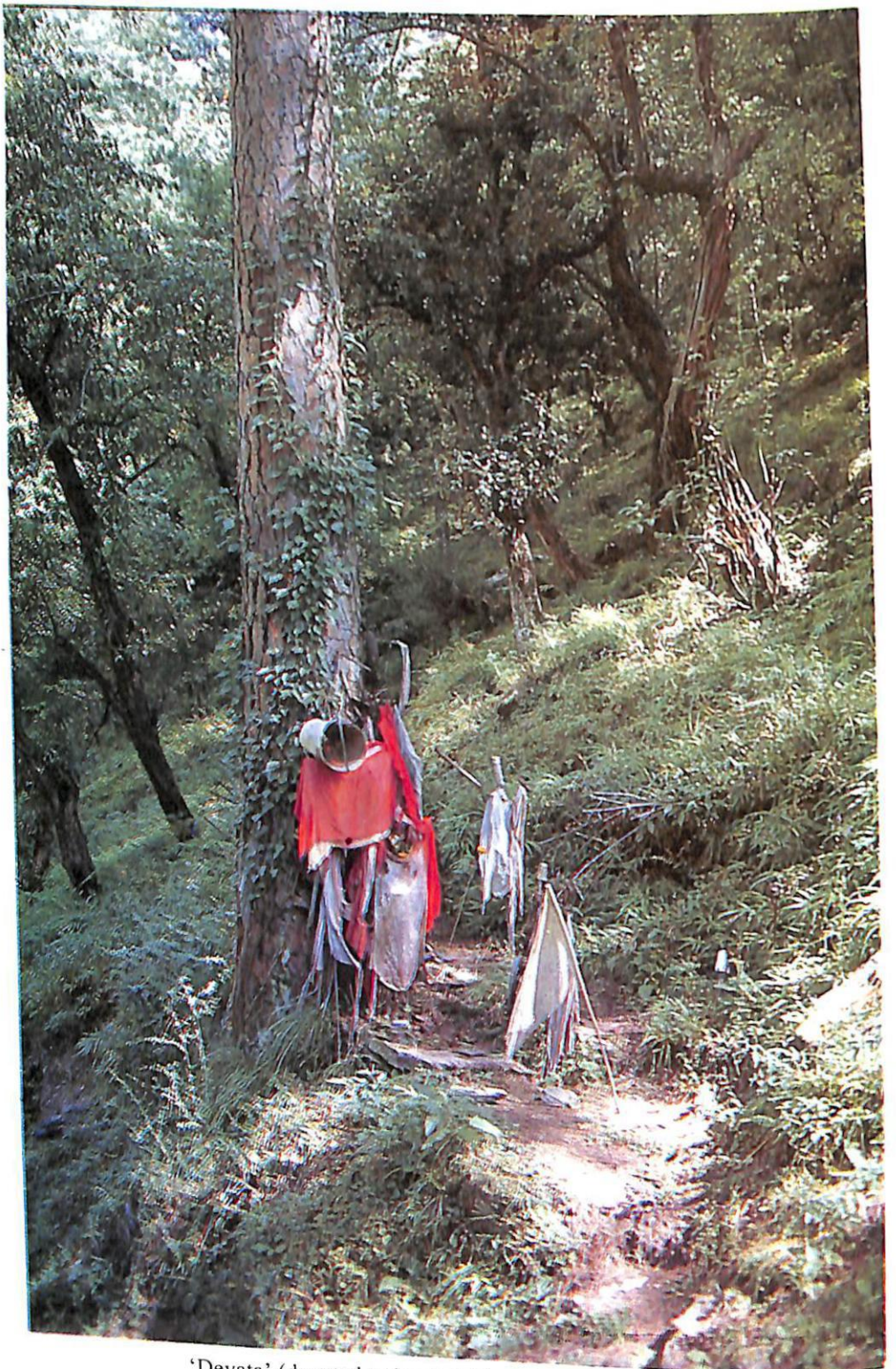
A view of Man-Talai area in the Parvati valley of GHNP



Grazing by sheep and goats in Nada Thach (3300 m), Tirthan valley



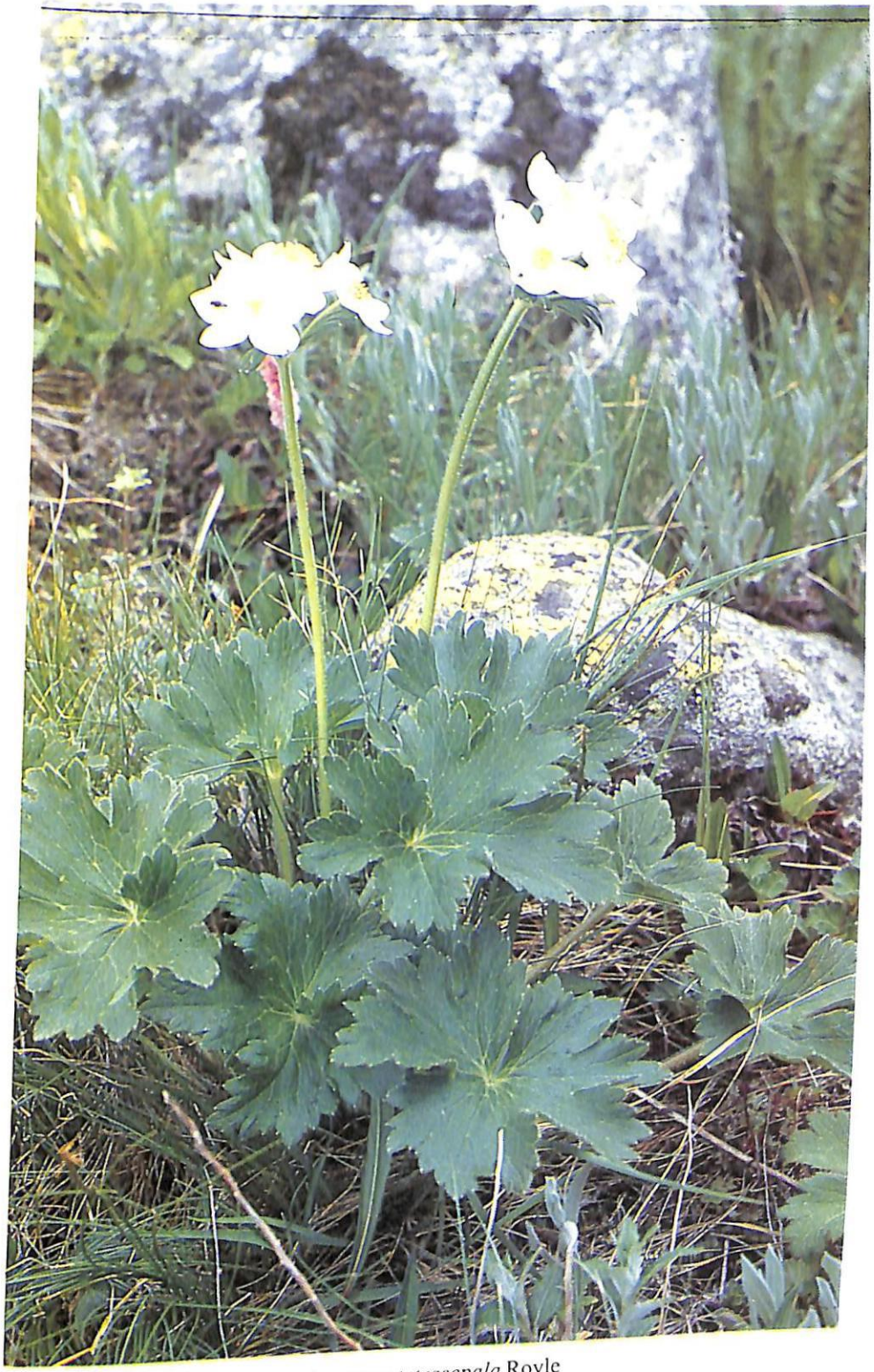
Majhan village (2700 m) full of *Euphorbia pilosa* L.
in the Jiwa Nal valley of GHNP



'Devata' (devoted to local deities) tree on way to Tirth

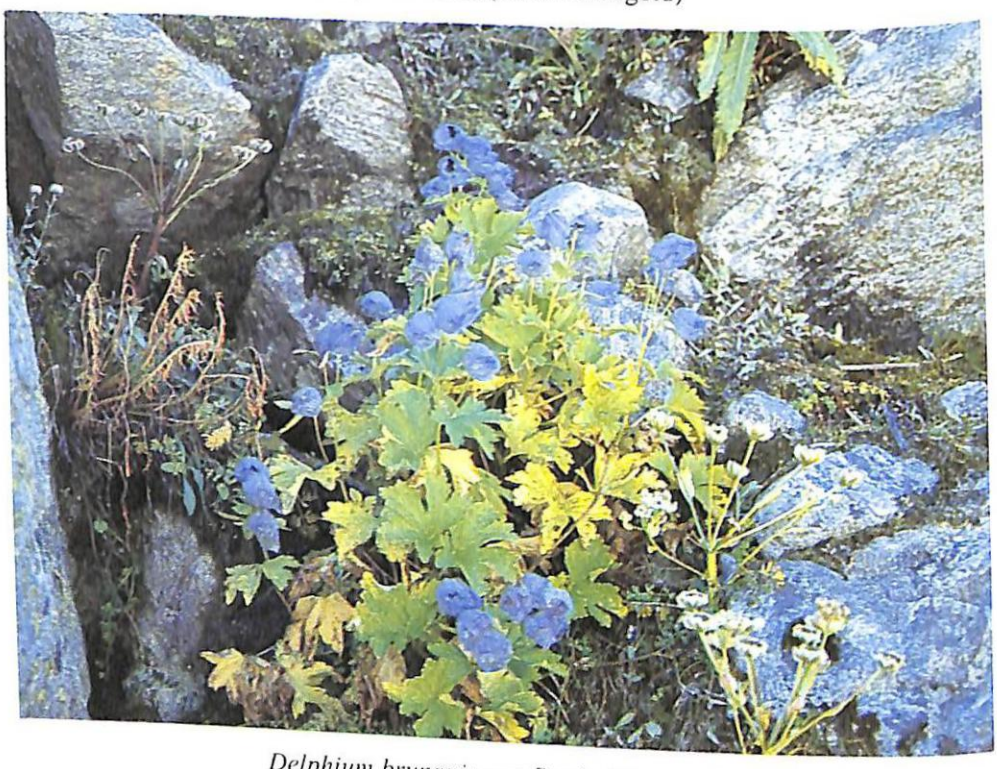
*Aconitum violaceum* Jacq. ex Stap. (Mitha-patis)

*Aconitum laeve* Royle (Mohra)



*Anemone tetrasepala* Royle

*Caltha palustris* L. (Marsh marigold)



*Delphium brunonianum* Royle (Kashturilata)

*Climate*

The GHNP has typical temperate and alpine climate. Most of the area (approx. 68%) falls under alpine zone, which remains snow covered during winter months (November-March). Broadly, three seasons can be recognised for the Park area *viz.* summer, (April to June), rainy (July to September) and winter (October to March). Winter experiences severe cold and main precipitation is received in the form of snow.

The mean annual precipitation in the Kullu district at middle elevation ranges between 1000-2000 mm and more than half of it falls during monsoon (Gaston *et al.* 1981). The mean annual rainfall recorded at Niharni (1800 m) in GHNP for the year 1992-94 was 1155.67 mm as shown in Fig 2a, while at Sainj (1450 m) for 1992-94 it was 1158.26, Fig. 2b. The maximum snow depth recorded was 5-7 m in the subapline and alpine areas during February. With the rise in temperature in the month of March snow starts melting in the lower altitudes and by April it remains in scattered isolated patches below 3000 m especially in shady localities. However, snow melting takes place only during May-June in the alpine zone.

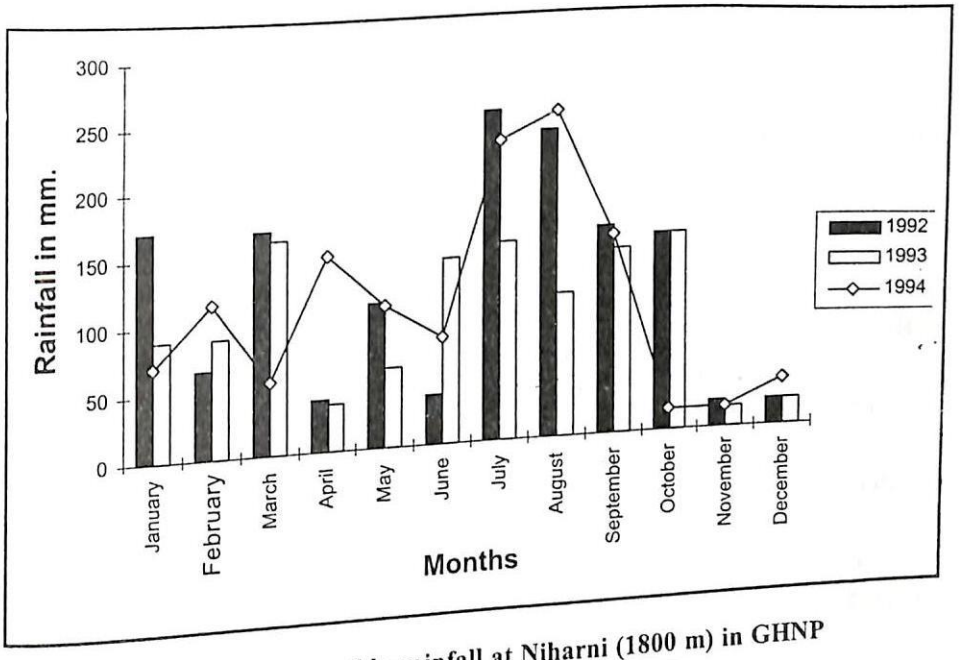



**Fig. 2a. Mean monthly rainfall at Niharni (1800 m) in GHNP**
(source: Office of the Director, GHNP)

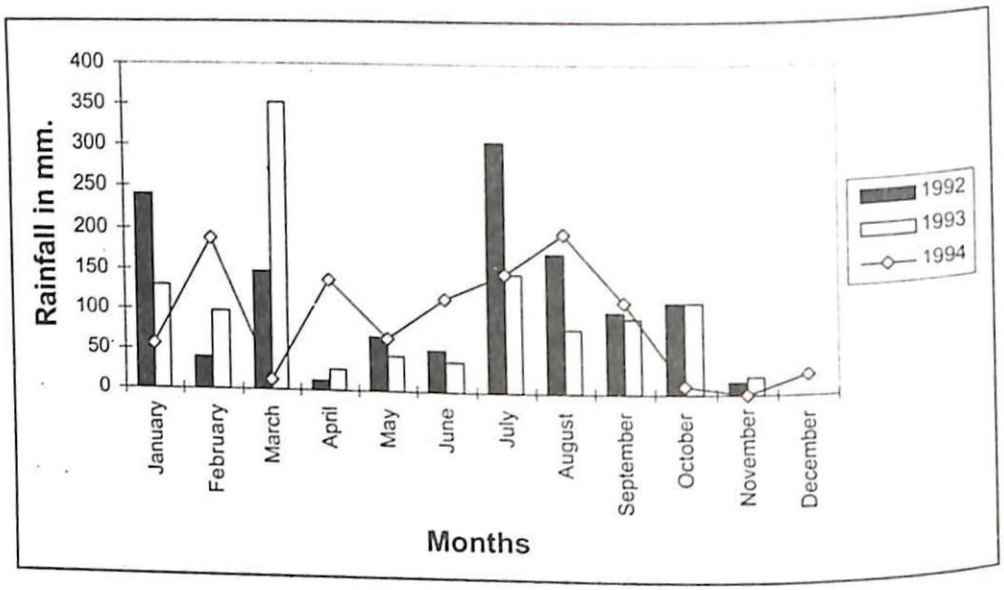



**Fig. 2b. Mean monthly rainfall at Sainj (1450 m) outside GHNP**
(source: Office of the Director, GHNP)

Temperature is an important factor in determining vegetation types. In general the temperature of the area varies from several degrees below zero (alpine areas) to 35°C. The temperature recorded at the different check-posts in three valleys is shown in Fig. 2c. The mean minimum and mean maximum temperature for the year 1997 in different valleys of GHNP (Tirthan, Sainj and Jiwanal) were 12.65°C, 9.59°C and 9.69°C and 16.38°C, 15.03°C and 13.46°C respectively. January being the coldest and June the hottest month of the year.

Mean maximum and minimum temperature in the selected alpine sites were recorded with the help of the graziers who stay there during summer months. The mean minimum and mean maximum temperature for June-July at Tirth (3800 m) during 1997 were 7.73°C and 11.23°C respectively. The low temperature values are shown in Fig. 2d. The total rainfall recorded during these months was 1298 mm.

***Vegetation***

Based on the general appearance, the following categories of vegetation can be identified in GHNP: a) Forests, b) Scrub vegetation, c) Temperate grassland and forest blanks, d) Alpine meadows. These categories are further divisible into several physiognomic units (Table 4).

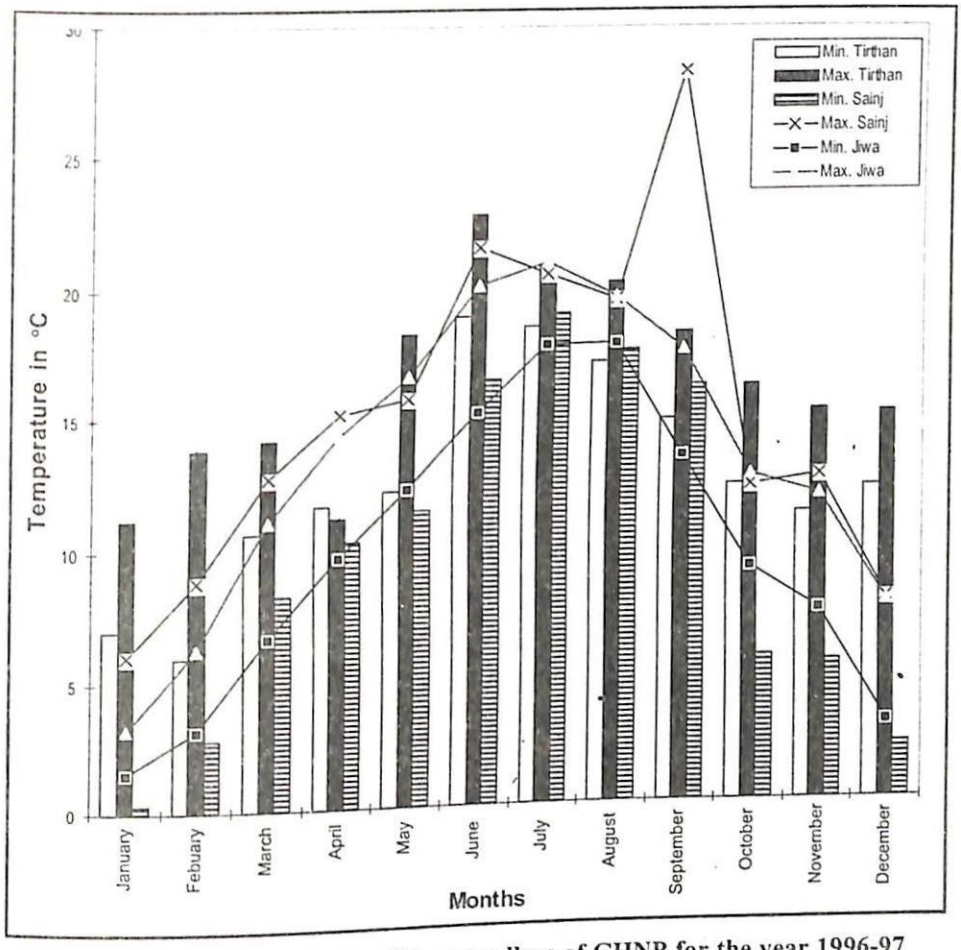



**Fig. 2c. Temperature in the different valleys of GHNP for the year 1996-97**

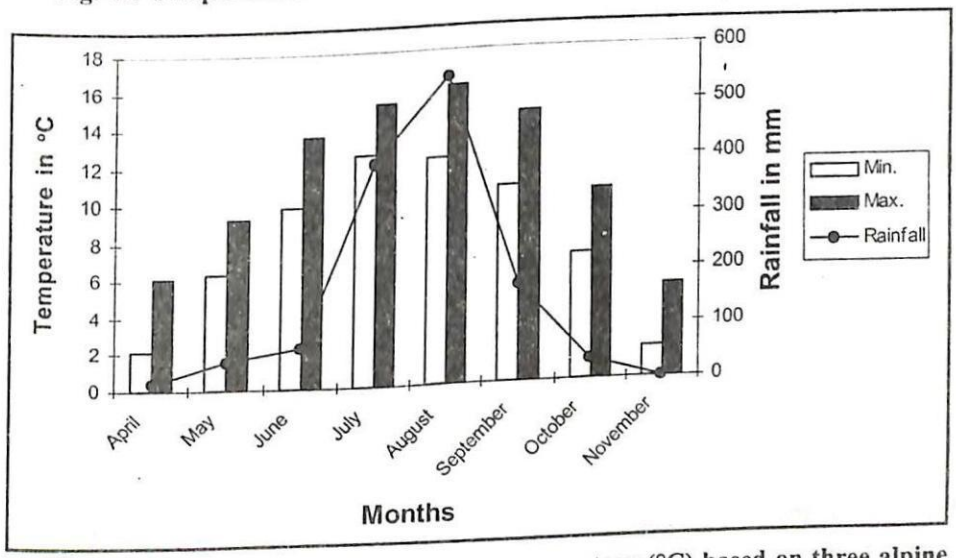



**Fig. 2d. Mean monthly rainfall (mm) and temperature (°C) based on three alpine sites i.e. Tirth (3800 m), Nada (3400 m), and Gumtrao (3550 m) in GHNP.**

**Table 4.** Major physiognomic units and their equivalent categories as per classification of Champion and Seth (1968).

| S.N. | Physiognomic Unit | C & S equivalents | |
|---|---|---|---|
| 1. | Chir Pine Forest | 9/C1b | Temperate Chir Pine Forest |
| 2. | Temperate Broadleaved Forest | 12/C1a | Ban oak forest (Evergreen) Forest |
| | | 12/C1b | Moru oak |
| | | 12/C2a | Kharsu oak |
| 3. | Temperate Broadleaved (Moist deciduous) Forest | 12/C1e | *Aesculus - Acer - Juglans* |
| | | 12/C2c | *Acer - Carpinus - Corylus* |
| | | 12/IS1 | Alder Forest (Riverine) |
| 4. | Temperate Conifer Forest | 12/C1f | Low alt. Blue Pine |
| | | 12/2S1 | High alt. Blue Pine |
| | | 12/C1c | Moist Deodar |
| 5. | Temperate Broadleaf-Conifer(mixed) Forest | 12/C1d | Fir - Birch |
| | | 12/C2b | Kharsu oak - fir |
| 6. | Sub-alpine Forest | 14/C1a | Sub-alpine fir |
| | | 14/C1b | Sub-alpine fir - birch |
| 7. | Temperate Secondary Scrub | 12/c1/DS1 | Ban oak Scrub |
| | | 12/c1/DS2 | Temperate Scrub |
| | | 12/DS1 | Bamboo Brakes |
| | | 12/DS2 | Himalayan Parklands |
| | | 13/IS1 | *Hippophae* Scrub |
| 8. | Alpine Scrub | 15/C1 | Birch - *Rhododendron* (*Krummholz*) |
| | | 15/C2 | Deciduous Scrub |
| | | 15/C2/E1 | Dwarf Rhododendron Scrub |
| | | — | Riverine willow Scrub |
| 9. | Temperate Grasslands | 12/DS3 | *Themeda, Chrysopogon Heteropogon* |
| | | 14/DS1 | Sub-alpine pastures (*Thaches* in forest blanks) |
| 10. | Alpine Meadows | 15/C3 | Alpine pastures |
| 11. | Alpine scree slopes and rocky areas | — | — |

Singh and Rawat (1999) and Singh (1999) have reported a total of 45 plant communities from Tirthan and Sainj Valleys during the investigation of plant communities in the area. Only three communities were found similar in both the valleys. 33 herbaceous communities were segregated in sub-alpine (9) and alpine (24) zones. The density and Importance Value Index (IVI) of different tree species in the different climatic zones shows that *Abies pindrow* was present in almost all climatic zones. The highest overall density was calculated for lower temperate zone of Sainj (214.88 $ha^{-1}$) and highest basal area for temperate zone of Tirthan valley (17685.27 $cm^2$ per 500 $m^2$). The highest IVI recorded in different zones were *Abies pindrow* (76.18) in lower-temperate, *Quercus floribunda* (150) in temperate, *Quercus semecarpifolia* (107.83) in upper temperate and *Rhododendron campanulatum* (101.22) in subalpine zone. In all cases A/F ratio showed contiguous distribution pattern. The highest diversity was recorded for *Cedrus deodara*, *Picea smithiana* community (H'=2.92) in Tirthan valley and *Cedrus deodara*, *Pyrus pashia* community (H'=1.81) in Sainj valley. In alpine zone highest diversity was recorded for *Rhododendron anthopogon*, *Poa alpina*, *Juncus thomsonii* community (H'=2.64). In general species diversity in lower and higher altitudes was lower than the middle altitude. Species richness and evenness showed almost same pattern. Pattern of total shrub density also varied from zone to zone and in general the shrub density was higher in lower temperate zone (2966.67 $ha^{-1}$). The noteworthy feature of shrub layer was prevalence of bamboo species in most of the broad-leaved forest. *Sinarundinaria falcata* dominated the temperate zone (below 2000 m) and was replaced by *Thamnocalamus spathiflorus* at higher altitudes (2500-3300 m). The other frequent genera of the shrub layer were *Berberis*, *Desmodium*, *Juniperus*, *Indigofera*, *Rhododendron* and *Viburnum*. The dominant species of alpine zone were *Rhododendron anthopogon*, *Juniperus communis* and *Salix* spp. The overall densities of seedlings and saplings were low for *Quercus leucotrichophora*, *Quercus semecarpifolia*, and *Cedrus deodara* suggesting a low rate of regeneration. *Taxus wallichiana* a commercially harvested medicinal plant showed similar trend.

The GHNP has only about 17.0% geographical area under forest cover (Negi, 1996). This is due to preponderance of alpine areas beyond tree line such as meadows, rocky and snow bound areas. The dominant tree species in the temperate belt are *Abies pindrow*, *Cedrus deodara*, *Pinus roxburghii*, *Pinus wallichiana*, *Picea smithiana* and *Taxus wallichiana*, among the conifers and *Quercus leucotrichophora*, *Quercus floribunda*,

*Quercus semecarpifolia*, *Celtis tetrandra*, *Aesculus indica*, *Juglans regia*, *Acer* spp., *Prunus cornuta*, *Betula alnoides*, *Betula utilis*, *Toona serrata*, and *Populus ciliata* being common broad-leaved species. *Quercus semecarpifolia* forms the pure stands between 3000-3500 m. Small patches of *Quercus leucotrichophora* are found between 1800-2400 m with *Quercus floribunda* overlapped by *Quercus leucotrichophora* on the lower side and *Quercus semecarpifolia* on the upper zone. Generally *Abies pindrow* and *Picea smithiana* are seen in the northern slopes and stands of *Pinus wallichiana*, *Cedrus deodara* and *Quercus semecarpifolia* are seen on the southern slopes. *Alnus nitida*, *Populus ciliata* and *Salix wallichiana* are found near streams. Bamboo species are also found on the moist northern slopes in the Tirthan and Sainj valleys. Undergrowth and ground cover comprise species of *Indigofera* , *Viburnum*, *Sarcococca*, *Berberis*, *Iris*, *Polygonum*, *Impatiens*, *Rumex* and *Girardinia*. The tree line is characterised by birch-rhododendron forest, which is replaced by alpine scrubs characterized by *Rhododendron* and *Juniperus* species towards higher altitudes interspersed with meadows and rocky outcrops. Alpine pastures are known for preponderance of a large number of medicinal herbs such as *Aconitum heterophyllum*, *Picrorhiza kurrooa*, *Jurinea macropcephala*, *Nardostachys grandiflora*, and *Dactylorhiza hatagirea*. Besides, there are grassy slopes in the eco-development area, which have been developed and maintained as "Ghasnis" by the local people for hay.

***Flora and Fauna***

Although, Kullu district has been explored by a large number of botanists and naturalists for the floral and faunal surveys but no systematic floristic studies have been conducted within GHNP so far. Mehta *et al.* (1993) published a checklist of 309 angiosperm species from the Park based on a few surveys. The present work is the first attempt at giving a systematic treatment of the GHNP flora. The park is quite rich in the floral diversity compared to other parts of Himachal Pradesh and has been described under the chapter 'general observations' in this volume.

The fauna of the Park includes at least 31 species of mammals (Gaston and Garson 1993; Vinod *et al.* 1997), 300 species of birds (Gaston *et al.* 1993; Ramesh *et al.* 1998) and more than 125 species of invertebrates (Uniyal and Mathur 1998). The high altitude mammals are blue sheep (*Pseudois nayaur*), brown bear (*Ursus arctos*), snow leopard (*Uncia uncia*) and Himalayan ibex (*Capra ibex*). Himalayan tahr (*Hemitragus*

*jemlahicus*) and Himalayan musk deer (*Moschus chrysogaster*) usually inhabit areas above 3000 m. Low to middle altitude (1500 - 3000 m) species include serow (*Nemorhaedus sumatraensis*), rhesus macaque (*Macaca mullata*), barking deer (*Muntiacus muntjak*), jackal (*Canis aureus*) and goral (*Nemorhaedus goral*). Certain species have wide range of altitude *viz*. Himalayan black bear (*Ursus thibetanus*), common leopard (*Panthera pardus*), Himalayan yellow throated marten (*Martes flavigula*), langur (*Presbytis entellus*) and flying squirrel (*Petaurista petauriata*). Some the endangered pheasants found in the park are western tragopan (*Tragopan melanocephalus*), cheer pheasant (*Catreus wallichii*) and monal (*Lophophorus impeyanus*).

### *Local people and land use practices*

There are about 141 villages and 1362 families with a population of 9694 living in the buffer zone of GHNP. The literacy of the area is 17.6% (Negi 1996). The main occupation of these people is agriculture along with horticulture. However, rearing sheep and goats also fetches a good income. The extraction of medicinal plants and mushroom forms major source of secondary income. These activities in some cases, contribute as high as 65% of the total annual cash income. Rearing sheep and goats is still practiced on a fairly large scale as it is the traditional practice of many villagers. Animal husbandry is common practice for the farmyard manure and for milk products. Horticulture is becoming more popular in the area and raising orchards of apple, plum, walnut and cherry are being developed while maize, wheat and barley are generally cultivated as food crops.

### *History of management*

Based on the richness and abundance of wildlife, Tirthan valley was notified as sanctuary on 17$^{th}$ July 1976. Subsequently, a part of Tirthan sanctuary was included in GHNP on I$^{st}$ March 1984 for which settlement of rights and final notification has recently been completed. The Park was named as Jawahar Lal Nehru Great Himalayan National Park in mid 1989, but its original name is more popular. Administratively, Tirthan and Sainj valleys fall under inner Seraj and the forests come under Seraj Forest Division, while Jiwanal valley forms a part of Waziri Rupi (Gaston *et al.* 1981). The forests of Kullu district were settled between 1886 and 1896, by Alex Anderson (Anderson 1886), the then Commissioner of Kullu. The

area (including the study area) falls in the following four categories such as Reserved Forest, Demarcated Protected Forest (D.P.F.), Unclassified Protected Forest (U.P.F. class III) and Non Forest cultivated land (Sharma 1987).

There was very little commercial exploitation of the forests in the area prior to World War II mainly because of the inaccessibility (Garson and Gaston 1985). Some felling took place during World War II to meet the increased demand for the timber. Felling of certain species, notably *Abies pindrow*, increased between 1949-50 and 1979-80 under the fourth working plan but this appears to be confined to a small area. The local people on the other hand, have been using these forests for generations and continue to exercise number of rights in this area. These rights have been recorded in Anderson's settlement report of 1886. While only limited rights such as right of way, were allowed in the reserved forest, a large number of rights were given in demarcated forests II, including livestock grazing, extraction of timber and collection of fuel wood and NTFP. Local people have unlimited and unsettled rights in the unprotected forest class III. With the lapse of time, new areas were brought under class III ,forests which allowed clear felling and burning of the forests (Sharma 1987). The Himachal Pradesh Government has recently suspended the rights to cultivate new areas in the unprotected class (III) forest but rights of herb collection, grazing of livestock and collection of NTFP have not been withdrawn.

The human population exists only on the western and the north-western boundary of the Park. The Himachal State Government imposed a moratorium on felling of timber trees in all the protected areas in 1984 and this has been upheld for this National Park. Likewise, a ban on hunting was imposed in 1982, which still continues and has shown a favourable result for the wildlife in this Park. The survey report by Himachal Wildlife Project (HWP I, II and III) indicated that GHNP had higher wildlife abundance in 1991compared to 1985 when the Park had not been established. The Park has now attained national as well as international significance for the conservation of flora, threatened birds and mammals (Gaston *et al.* 1981, Gaston and Garson 1993).

***Previous explorations and floristic studies***

Botanically north-western Himalaya has been explored since 19$^{th}$ century. Collett (1921) described 1236 species in *Flora Simlensis* from

Simla and neighbouring estates and gave a bibliography, which included almost all the published works pertaining to the area till 1921. The pioneer plant collectors from this region were Royle (1833-1840), Brandis (1879) and Parker (1918). Burkill (1908) gave an account of the spring flora of Simla Hills. Jain and Bhardawaj (1949) made collections from Parvati valley of GHNP and deposited the specimens to the Herbarium of Forest Research Institute, Dehra Dun (DD). Nair and Pant (1966) and Maheshwari (1972) reported few new records from the area. Bir (1963, 1968) and Khullar (1994, 1999) dealt with Pteridophytes of the area. A number of publications (*e.g.* Hooker 1906, Duthie 1906, Kashyap 1925, Blatter 1927-29, Collett 1921, Stainton 1977, Rau 1974, 1975, Kachroo *et al.* 1993) dealt with the floristic and phyto-geographical aspects of western Himalaya. Among more recent works on the flora of western Himalaya including Himachal Pradesh covering high altitude areas include Nair (1977), Sharma and Kachroo (1981), Dhar and Kachroo (1983), Polunin and Stainton (1984), Chowdhery and Wadhwa (1984), Rawat and Srivastava (1986), Deva and Naithani (1986), Singh (1992), Aswal (1993), Aswal and Mehrotra (1994) and Dhaliwal and Sharma (1999). From the ethno-botanical point of view some earlier works done in Himachal Pradesh include Uniyal and Chauhan (1973), on medicinal plants of Lahaul-Spiti forest division and Koelz (1979) on the ethnobotany of Lahaul. The more recent work includes Sharma (1976), Uniyal *et al.* (1983), Aswal and Mehrotra (1985), Chauhan and Chauhan (1988), Kapur (1993), Singh (1993), Gaur and Singh (1995), Singh (1996), Brijlal *et al.* (1996) and Singh and Rawat (1998a, 1998b) *etc.*

**Present study**

Despite a large number of floristic surveys in Himachal Pradesh, Beas catchment, which forms the present study area, had not been surveyed thoroughly till the initiation of present study. The present study deals with the systematic treatment of the higher plants (Angiosperms and Gymnosperms) found within GHNP based on an extensive survey of the flora and vegetation in the area during 1995-1998. Information on the population structure of the rare and threatened species, patterns of species diversity along with detailed notes on their habit and habitats have been incorporated in the flora. It is hoped that the information contained in this book would be of much use to the scientists and protected area managers working in the Western Himalaya. The methodology adopted for the study and analysis of flora is given below:

a. Systematic surveys were conducted for floral inventory covering all the major vegetation types (table 5) and seasons in various routes as described below.

1. A set of duplicate plant specimens were collected and preserved following Jain and Rao (1977).

2. The collected specimens were identified with the help of regional floras mentioned earlier and confirmed at the Herbarium of Wildlife Institute of India, Forest Research Institute of India and Botanical Survey of India, northern circle, Dehra Dun. The families are arranged according to the Bentham and Hooker's system of classification except for Gymnosperms (Hooker 1872-97). One set of Herbarium specimens of selected taxa has been deposited in the office of the Director, Great Himalayan National Park.

3. Information on various aspects *i.e.* medicinal, rare, endemic, endangered and valuable taxa was also collected for each species.

4. Diversity, Richness and Evenness values were calculated for different zones using SPSS/PC and STATECOL programs at the Wildlife Institute of India.

Species diversity (variety and variability) was computed using Shannon-Wiener Index (Shannon and Wiener 1949). The index makes the assumption that individuals are randomly sampled from an "infinitely large" population and also assumes that all the species from the community are included in the sample. The index was found appropriate, as it needs random sampling. Species diversity for different sites was calculated by Shannon Wiener (1963) formula.

$$H' = \Sigma_s^1 (Ni/N)\log 2 (Ni/N)$$

Where $H'$ = Shannon Wienner information index of species diversity
$Ni$ = Total number of individuals of one species
$N$ = Total number of individuals of all the species in one stand.

Richness was calculated by counting total number of species observed in each habitat and also by Menhinik's index given by Whittaker (1977) as

$$\text{Richness} = \frac{S}{\sqrt{n}}$$

Where,

S = The number of species

n = Total number of individuals of all species

Evenness (Equability) was calculated using the equation

Evenness = H'/H' max. = H' log S

Where S = Number of species

H' = Diversity

Which express H' as a ratio of maximum H' attainable when all species have equal abundance (with one individual / species *i.e.* log n (S)) or highest evenness possible.

**Table 5.** Areas of systematic plant collection and quantification of rare and vulnerable plants in GHNP

| Tr. # | Location | Primary strata | Altitude (m) | Landscape characteristics |
|---|---|---|---|---|
| T1 | Devata to Supdhar | LT | 1500-2000 | Cultivated and disturbed site in the eco-development area. |
| | | T | 2000-2800 | South facing slope of 30°-60° |
| | | UT | 2800-3300 | Rocky slopes dominated with *Quercus semecarpifolia* |
| T2 | Rolla to Tirth | T | 2000-2800 | Riverine |
| | | UT | 2800-3300 | Steep slope *Quercus semecarpifolia* |
| T3 | Rolla to Kholle Poe | T | 2000-2800 | North facing slope of *Abies pindrow* |
| | | UT | 2800-3300 | North facing slope of *Abies pindrow* |
| T5 | Manoni to Gushani | LT | 1500-2000 | South facing slope maintained for village pasture 'Ghasani' |
| | | T | 2000-2800 | Semi-cultivated land |
| | | UT | 2800-3300 | Rocky and bouldery area |
| T6 | Chota-Basu to Silt | LT | 1500-2000 | Semi-cultivated area dominated by *Quercus leucotrichophora* |
| | | T | 2000-2800 | Scrub land area |
| | | UT | 2800-3300 | South facing rocky slope |
| T8 | Gushani to Ropa | LT | 1500-2000 | South facing moist area |
| T9 | Bathad to Khain | LT | 1500-2000 | Riverine vegetation mixed with conifers. |
| | | T | 2000-2800 | |

*table 5 contd...*

| Tr. # | Location | Primary strata | Altitude (m) | Landscape characteristics |
|---|---|---|---|---|
| S1 | Majhangalu to Nevali | LT | 1500-2000 | Semi-cultivated area |
| | | T | 2000-2800 | Riverine |
| | | UT | 2800-3300 | Moist north facing slope |
| S2 | Lapah to Sara thach | T | 2000-2800 | South facing slope with dense coniferous forest |
| | | UT | 2800-3300 | Forest opening |
| S3 | Shakti to Maror top | T | 2000-2800 | Riverine |
| | | SA | 2800-3300 | Exposed north facing slope |
| S4 | Lapah to Dhela | T | 2000-2800 | Riverine valley |
| | | UT | 2800-3300 | North west facing slope |
| S5 | Sangard to Lapah | LT | 1500-2000 | The disturbed slope in eco-development area |
| | | T | 2000-2800 | Coniferous forest |
| S6 | Nevali to Saran | LT | 1500-2000 | Village pasture "Ghasani" |
| | | T | 2000-2800 | Semi-cultivated land |
| J1 | Seuyand to Majhan | LT | 1500-2000 | Semi-cultivated land |
| | | T | 2000-2800 | Steep slope used by graziers |
| | | UT | 2800-3300 | Moist broad leaved slopes |

# GENERAL OBSERVATIONS

## *Floristic Structure and Species Diversity*

A total of 832 plant species belonging to 427 genera and 128 families of higher plants were recorded within GHNP. The species have been well described in alphabetical order within each family which follows the sequence of Flora of British India (Hooker 1872-97). Each species is given with authority. The nomenclature follows Rau (1975), Bennet (1988) and Aswal and Mehrotra (1994). Detailed taxonomic treatments (citation and keys for identification) are not given to avoid repetition from the literature cited above. Of this, 794 are Angiosperms, 11 Gymnosperms and 27 ferns. The ratio of family to genera is 1:3.33, family to species 1:6.50, and genera to species 1:1.94. This conforms more or less with that of Simla (1:2), Naini Tal (1:2), Mussoorie (1:1.87) and Kangra (1:1.72). However, this ratio is less in comparison with corresponding ratio of 1:13 for world, 1:7 for British India and 1:6 for India (Raizada & Saxena, 1978). The distribution of species in various groups is given below (Table 6).

**Table 6.** The number of families, genera and species in GHNP

| Groups | Families | Genera | Species |
|---|---|---|---|
| Angiosperms | | | |
| a. Dicots | 94 | 308 | 634 |
| b. Monocots | 17 | 95 | 160 |
| Gymnosperms | 4 | 8 | 11 |
| Ferns | 13 | 16 | 27 |
| Total | 128 | 427 | 832 |

According to the growth habit these species are distributed over 69 trees, 113 shrubs, 28 climbers, 493 herbs, 96 graminoides and 27 ferns (Table 7). The fern species are listed under Appendix II.

**Table 7.** Distribution of flora of GHNP according to growth habit

| Habit | Angiosperms | | Gymnosperms | Grasses & Sedges | Ferns | Total |
|---|---|---|---|---|---|---|
| | Dicots | Monocots | | | | |
| Trees | 61 | 0 | 8 | – | – | 69 |
| Shrubs | 107 | 3 | 3 | – | – | 113 |
| Climbers | 25 | 3 | – | – | – | 28 |
| Parasites | 6 | – | – | – | – | 6 |
| Herbs | 435 | 58 | – | – | – | 493 |
| Grasses and Sedges | – | – | | 96 | – | 96 |
| Ferns | – | – | – | – | 27 | 27 |
| Total | 634 | 64 | 11 | 96 | 27 | 832 |

Temperate zone constitutes only about 31.2% of the geographical area but it harbours more than 600 species distributed over 311 genera. The subalpine zone has lowest number of genera (135) distributed over 311 species. The distribution of species in different altitudinal zones is given below (Table 8).

**Table 8.** Habitat wise distribution of species in various altitudinal zones

| **Altitudinal Zones m.** | **Genera** | **Species** | **Trees** | **Shrubs** | **Climbers** | **Herbs** | **Grasses & Sedges** |
|---|---|---|---|---|---|---|---|
| Lower Temperate (1500-2000) | 223 | 448 | 59 | 80 | 19 | 216 | 74 |
| Mid - Temperate (2000-2800) | 311 | 624 | 62 | 92 | 22 | 368 | 80 |
| Upper Temperate (2800-3300) | 220 | 468 | 35 | 67 | 14 | 294 | 58 |
| Subalpine (3300-3600) | 135 | 311 | 8 | 30 | 3 | 252 | 18 |
| Alpine (>3600) | 158 | 387 | 3 | 63 | 1 | 281 | 29 |