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PHYTOSOCIOLOGY OF *PINUS ROXBURGHII* SARGENT. (CHIR PINE) IN LESSER HIMALAYAN AND HINDU KUSH RANGE OF PAKISTAN

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Abstract

A phytosociological study of *Pinus roxburghii* was undertaken in Lesser Himalayan and Hindu Kush range of Pakistan during summer 2005. Thirteen stands were sampled at five different locations i.e., Mansehra, Rawalpindi, Islamabad, Swat and Lower Dir ranging from 750 - 1700 meters elevation. *P. roxburghii* was forming pure vegetation in 12 stands but in one location, it was associated with some angiospermic tree species. Quantitative attributes viz. relative density, relative frequency and relative basal area and absolute values were calculated. Circular plots were used to assess the vegetation association on the forest floor. Pine seedlings were recorded in nine stands. The common angiospermic species were found in association with Chir pine like *Dodonaea viscosa, Punica granatum, Erodium cicutarium, Medicago denticulate* and *Vicia sativa.* The most rare species encountered were *Ailanthus altissima, Daphne mucronata, Melia azedirach, Potentilla nepalensis, Urtica dioica* and *Olea ferruginea.* It was also observed that the studied forests are unstable and degraded and would be vanished if not maintained properly.

Introduction

Pinus roxburghii is distributed in sub tropical Western Himalayan region of the South-West summer monsoon and reported from Indian occupied Kashmir, Punjab, Himachal Pradesh, Uttarakhand, Sikkim, Nepal and Bhutan. In Pakistan, it is growing in lower parts of NWFP, Panjab and Azad Kashmir. This species has wide ecological and economic values. It is used as antiseptic, diaphoretic, diuretic, rubefacient, stimulant and vermifuge. It is also used as charcoal, dye, herbicide, ink, lighting, resin and wood. [46] Uphof. J. C. Th. *Dictionary of Economic Plants* Weinheim 1959.

Vegetation of different parts of northern area was described by various workers. Chaudhri,(1960), described vegetation of Kaghan valley. Hussain (1969a,b) described the vegetation of Ayub National Park and Wah Garden respectively. Ahmed & Qadir (1976) and Ahmed (1976, 1986, 1988) has carried out an extensive Phytosociological survey in northern areas of Pakistan, during a scientific expedition. Amin & Ashfaque (1982), Beg & Khan (1984) and Qadri (1986) presented Phytosociological work from Ayub National Park, dry oak forest zone in Swat and Kotli Hills of Azad Kashmir. Phytosociology of vanishing subtropical vegetation of Swat and ethno ecological profile of Harboi rangeland of Kalat was investigated by Hussain & Shah (1991), Durrani & Hussain (2005). Hussain & Illahi (1991) also presented an extensive work on ecology and vegetation types for lesser Himalayan Pakistan. However little attention is paid to describe structure of different forests in Pakistan.

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Population structure of planted tree species of Quetta was presented by Ahmed (1988), while population structure and dynamics of *Juniperus excelsa* M.B. from Rodhmallazai (Ahmed *el al*., 1990), *Juniper* track (Ahmed *et al*., 1990) and *Pinus gerardiana* Wall. ex Lamb from Zhob District were described by Ahmed *et al*., (1991). Ahmed *et al*., (2006) also presented an extensive work on Phytosociology and structure of various Himalayan forests from various climatic zones of Pakistan. Recently Wahab *et al*., (2008) described Phytosociology and dynamics of some pine forest of Afghanistan, close to the Pakistani border. Beside these individual and localized works from a few areas of Pakistan, no comprehensive quantitative investigations were carried out to describe population structure of different forest trees of Pakistan. Keeping in mind, the present repoted give an account of the population structure and quantitative description of *Pinus roxburghii*, in Lesser Himalayan and Hindukush range of Pakistan.

Material and Methods

Thirteen stands of Chir pine, throughout Pakistan were included in this study. Mature and least disturbed vegetation was selected for quantitative sampling. The criteria of vegetation sampling were:

1. That it should contain pine trees at least 50 cm dbh (diameter breast high)
2. There should be no sign of recent disturbance.
3. It covered at least two ha^{-1} in area. Point Centered Quarter Method (Cottam & Curtis, 1956) was used to sample 13 stands. In each stand, 20 points were taken at 20-meter intervals.

Phytosociological attributes (relative density, relative frequency & relative basal area) and absolute values (density ha^{-1} and basal area of species m^2/ha^{-1}) were calculated, according to the method described Mueller-Dombois & Ellenberg (1974). Aspects, elevation, soil compaction, slope angle, longitude and latitude of each stand were recorded, using GPS. Importance Value Index (Brown & Curtis, 1952) was used to rank each species and the plant species with the highest importance value in the stand was considered the dominant species. The plant community was named on the basis of dominant species and the floristic composition. Diameter breast high (dbh) of individuals in a stand were divided into (10cm dbh) various size classes and size structure of pine and associated angiospermic trees are presented. A species list with a relative frequency for understorey (ground flora) plants (<10 cm dbh) is presented, using a circular plot (2 m diameter) at each sampling point. Plants specimens were collected from the studied area and identified with the help of flora of Pakistan (Nasir & Ali, 1972).

Results and Discussion

Locations of sampling sites are shown in Fig. 1 while the ecological characteristics of each sites are described in Table 1. It is indicated that *Pinus roxburghii* is distributed from 750m to 1700m elevation facing predominantly North from moderates (23°) to extremely steep (45°) slope. Due to anthropogenic disturbances, at many locations, the canopy moderately or completely open. Soil compaction was ranged from 120 to 250 (Table 1).

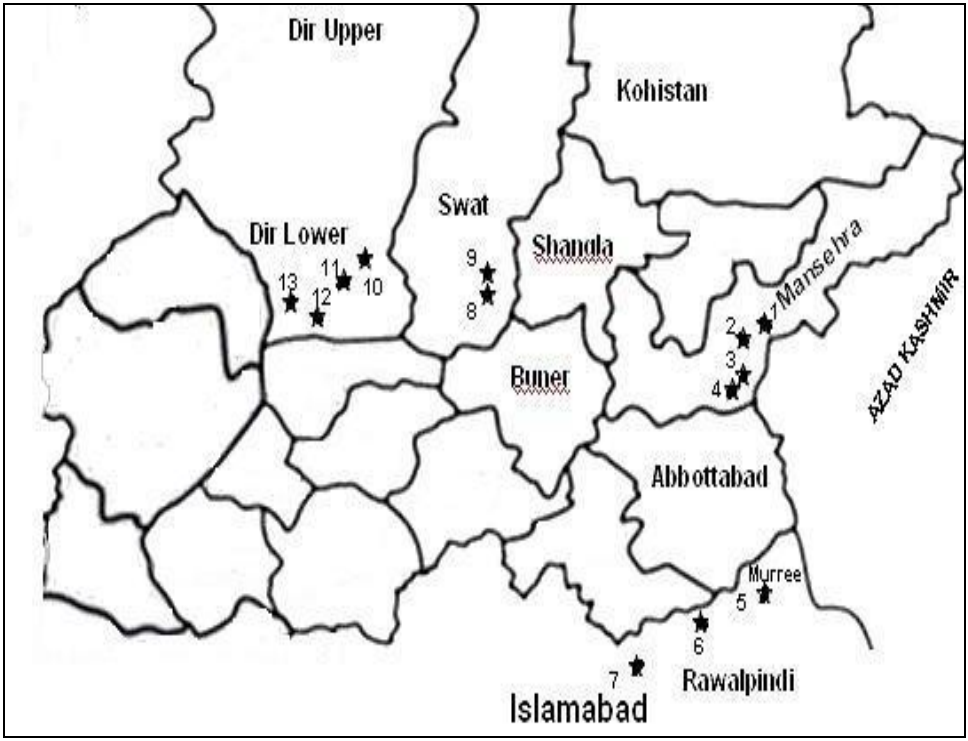

Fig. 1. Map showing *Pinus roxburghii* sampled forests. Asterisk with numbers are sampling stands. Detail about sampling Locations are given in Table. 1

Mean monthly temperature, relative humidity and precipitation data of five main sampling locations was presented in Fig. 2. It is evident that distribution of mean monthly minimum temperature is almost same at all locations. Similarly mean monthly relative humidity at 0000 UTC was almost same in the month of July and August. The amount of precipitation however was different in March, July and August. It is suggested that this difference in rainfall is associated with poor floristic similarity of ground flora between many stands.

Summary of phytosociological analysis showed that except one location, all stands of *Pinus roxburghii* are distributed as pure form (Table 2). At Islamabad (Shakarparian) *Pinus roxburghii* formed a *Pine-Acacia* community, associated with *Broussonetia papyrifera* and *Cedrela serrata* with importance value of 22%. Similarly at Malakand and Swat Marghazar (not in present study) *Olea furruginea* was associated with *Pinus roxburghii* and Ahmed *et al*., (2006) described it under lower pine forest of sub tropical zone. Therefore present *Pinus-Acacia* community should also be considered as part of the same zone. However some previous worker like Champion *et al*., (1965) described these forests as Himalayan Pine Forest. Hussain (1969) and Baig (1975) kept these forests under dry temperate and Himalayan dry Chir pine respectively while, Naqvi (1976) described these forests under Montane zone.

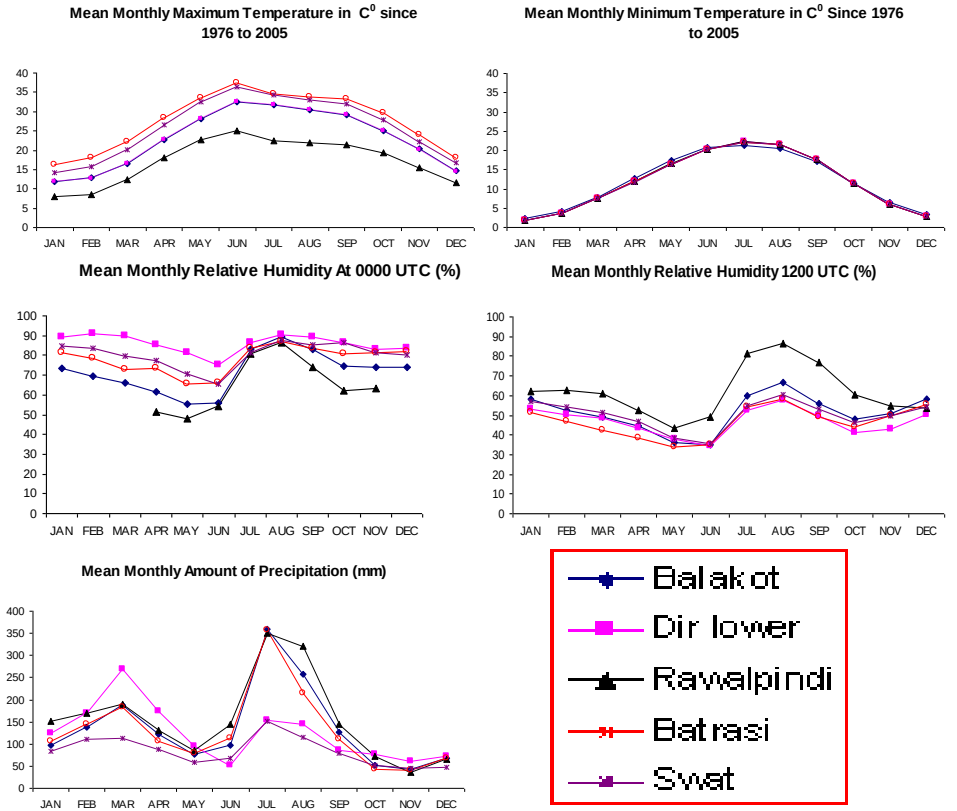

Fig. 2. Mean monthly climatic variables from five different locations, showing climatic range of *Pinus roxburghii* Sargent, distribution.
Note: At 0000 UTC = recorded at 12 PM, At 1200 UTC = recorded at 12 AM, UTC = GMT = Greenwich mean time.

This study describes, *Pinus roxburghii* as a pure stand, however it was also associated with *Quercus incana* under upper pine forests (Ahmed *et al.*, 2006). At higher elevations ecotonal of subtropical and moist temperate zone, it was associated with *Pinus wallichiana* and *Aesculus indica.* Ahmed *et al*., (2006) showed these forests under mixed pine forest while Hussain & Illahi (1991) described these forests as sub tropical Chir-Blue pine ecotonal forests. These forests are highly disturbed due to the removal of all the broad leaved trees for fuel and fodder. During the continuous resin collection, all the surrounding trees and bushes were either felled or destroyed by continuous trampling. Except from the top of the tree, all branches are chopped for fuel purposes. The forests like Batrasi are also subjected to periodic fire and all large trees were chopped. The effect could be seen in the forest that lower portion of all trees are burned, injured and misshaped. Ground flora is rare without any broadleaved trees, bushes and herbs. At many places, soils have been washed out and rocks are exposed. However from nine stands Chir pine seedlings are recorded. It is suggested that if proper care and management is provided, at least these nine stands could be saved. To stop soil erosion and to increase regeneration, burning, overgrazing and removal of broad leaved trees and bushes should be stopped for at least ten to fifteen years.

Frequency size classes of Chir pine (Fig. 3) showed that lowest density (41/ ha^{-1}) of Chir pine was recorded from Anbarzie site, while highest density (769/ ha^{-1}) was recorded from Daddar. Highest basal area (118 m^2 ha^{-1}) was recorded from Company Bagh, while lowest (9 m^2 ha^{-1}) was calculated from Kattan Bala. As seen in Table 2, density and values of basal area between the stands are highly variable. Ahmed *et al*., (1990) reported the same from Juniper forest of Baluchistan.

Density and values of basal area of some other forests are also recorded for comparison. Values in *Pinus gerardiana* ranged between 24 to 930 trees /ha with the average basal area of 25.5m^2 ha^{-1} (Ahmed *et al*., 1991). A density of 54 to 154/ha^{-1} with 9.0 to 77m^2 ha^{-1} basal area was reported by Ahmed *et al*., (1990a) from Juniper forest of Rodhmallazi, Balochistan. The density of Juniper (> 6cm dbh) ranged from 56 to 332 trees ha^{-1} with a range of 9.0 to 152 m^2ha^{-1} basal area was reported by Ahmed *et al*., (1990b) from *Juniper* track of Baluchistan. Ahmed *et al*., (2006) presented stand density and basal area values from various Himalayan forest of Pakistan. For example, a Chir pine community from upper pine forest showed a density of 732 individual's ha^{-1} with 31 m^2ha^{-1} basal area. Broad leaved communities or forests generally showed higher density with low values of basal area. On the basis of these investigations, it is stated that density and basal area values recorded during the present study is in accordance with previous studies.

Table 3 indicated that 63 angiospermic shrubs, herbs and grasses were associated with *Pinus roxburghii*, however at many locations ground flora was poor and consisted only a few species. Out of 63 species, 53 were recorded from only one or two stands with a fairly low relative frequency. In these species *Tripogon filiformis, Chrysopogon auchuri, Malvastrum coromandelianum, Phacelurus speciosus, Podophylum emodi, Pupalia lapacea* and *Setaria glauca* were locally abundant and found 5 to 20% in circular plots. Thirteen species were found in 3 to 5 stands with low relative frequency, However seedling of *Pinus roxburghii* were recorded in 9 stands. *Dodonaca viscosa* was recorded in 4 to 46% of circular plots.

Comparatively large number of angiospermic species (16-21) were found in Dir, while in Swat 8 to 9 species were recorded as a ground flora. Only three species were found in Mansehra Chir pine forests probably due to the periodic fires, overgrazing and soil erosion. It is also recorded that at sites, there was diversity of dominant species on forest floor, hence poor floristic similarity between sites. For example, in Lower Dir, Company Bagh, Dushkhel, *Dodonaea viscosa*, *Rumex hastatus* and *Micromeria biflora* were distributed in 70 to 80% of the circular plots, while at Kaltan Bala's forest floor was dominated by *Medicago denticulata*, *Micromeria biflora* and *Vicia sativa* Chir pine forest of Anbarzie supported *Mentha longifolia*, *Rumex hastatus* and *Micromeria biflora* on forest floor while at Yarkhan Banda *Mentha longifolia*, *Ajuga bracteosa*, *Vicia sativa* and *Dodonaea viscosa* occupied the forest floor. Difference in associated species (poor floristic similarity) on forest ground may be due to difference in disturbance, grazing, topography, soil moisture or physical or chemical nature of the soil.

Frequency size class structure of different Chir pine stands are shown in Fig 3. Balakot, Dadder, Company Bagh and Marghazar showed number of individuals in small size classes with a gradual decrease in bigger classes. These stands can be maintained by increasing number of seedlings and reducing disturbance (overgrazing and cutting).

Anbarzie, Bagh Dushkhel, Batrasi and Tret showed no trees in small size classes, indicating no regeneration for the last 20 to 40 years. Some of these stands showed less number of trees in higher size classes. These forests showed unstable and degraded situation and if they will not be maintained, there is possibility that we may not see them in future.

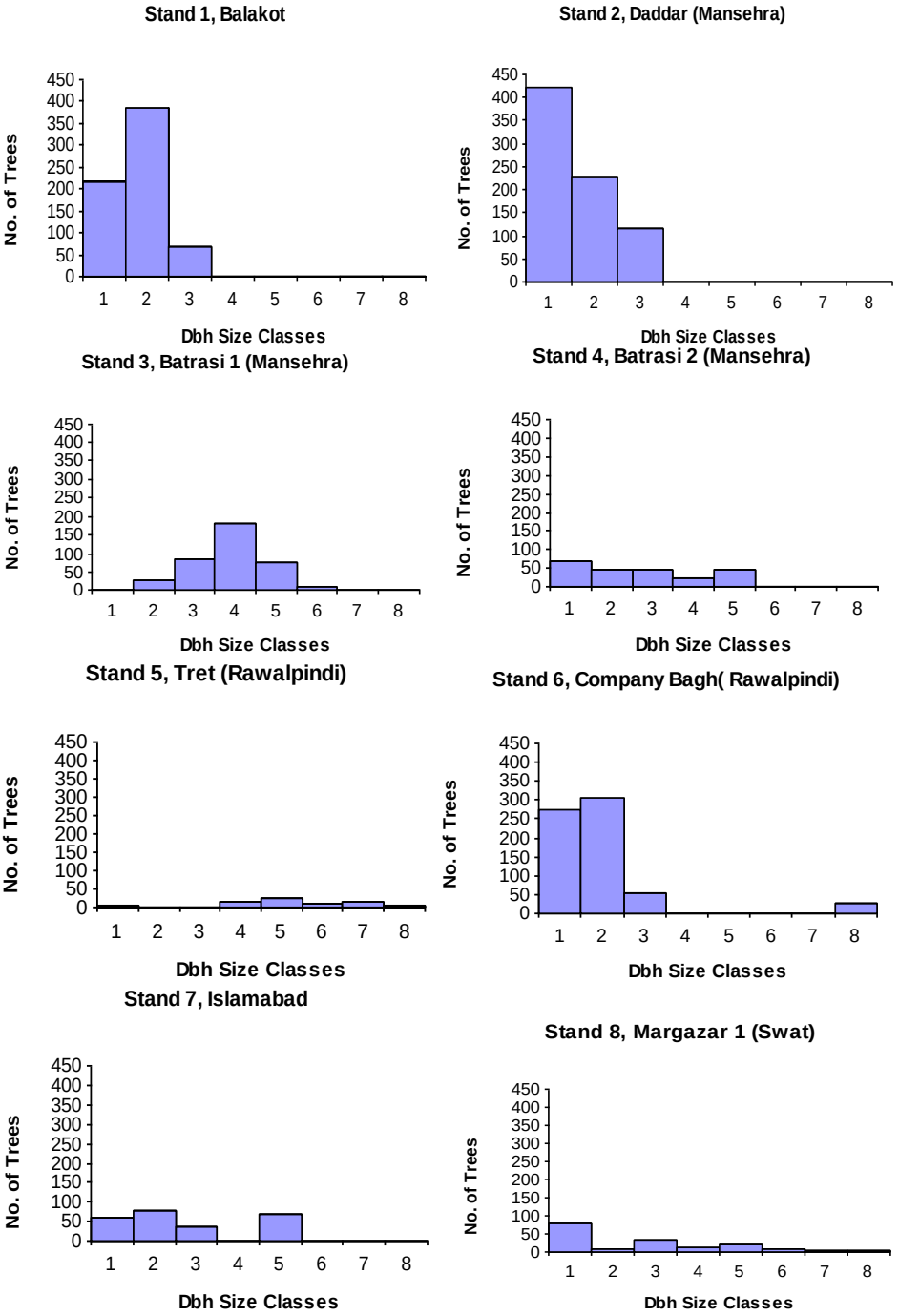
Stand 1, Balakot
Stand 2, Daddar (Mansehra)
Stand 3, Batrasi 1 (Mansehra)
Stand 4, Batrasi 2 (Mansehra)
Stand 5, Tret (Rawalpindi)
Stand 6, Company Bagh(Rawalpindi)
Stand 7, Islamabad
Stand 8, Margazar 1 (Swat)
No. of Trees
Dbh Size Classes
0
50
100
150
200
250
300
350
400
450
1
2
3
4
5
6
7
8

Fig. 3 Cont'd.

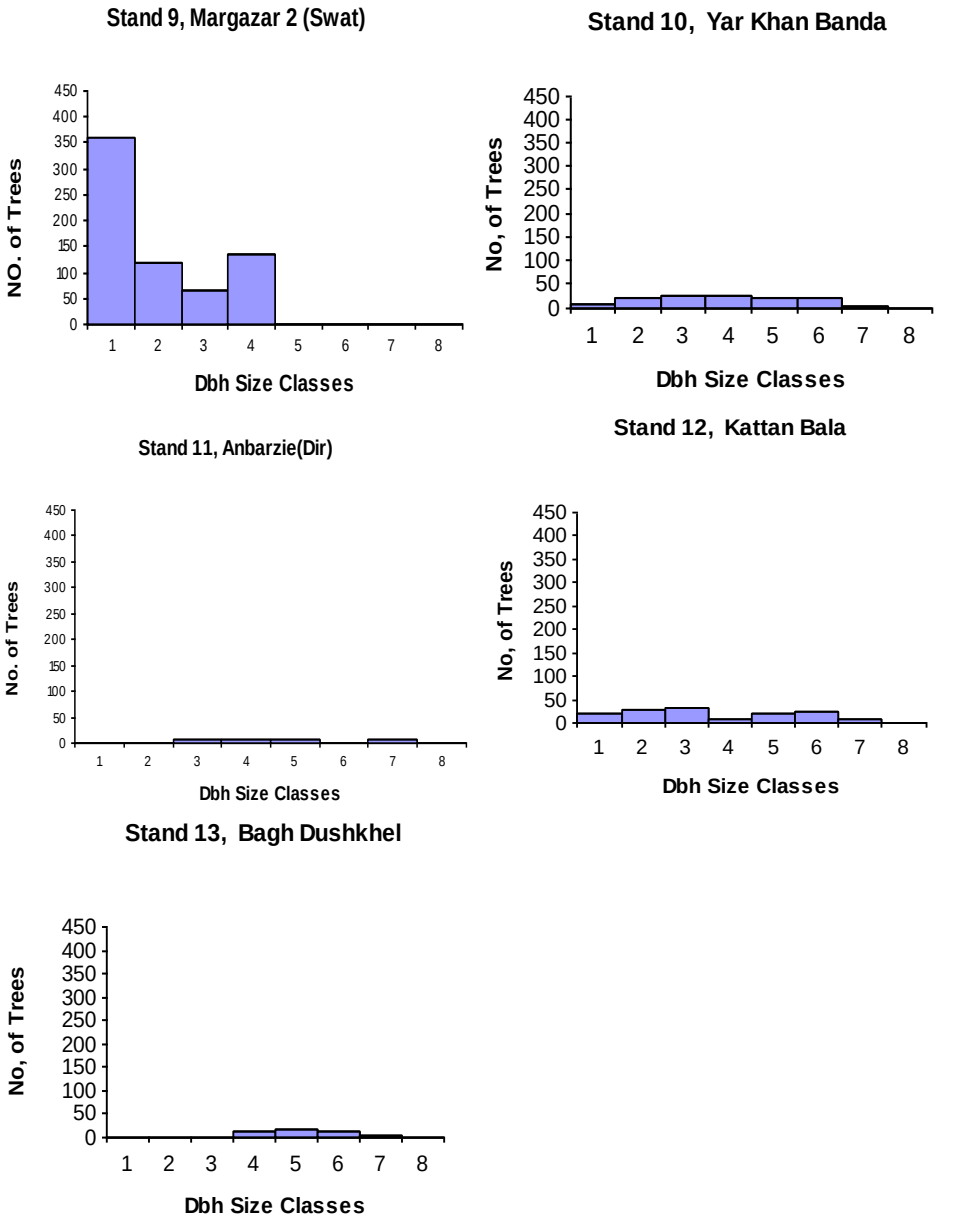

Fig. 3. Frequency size classes of Chir pine from various stands. Numbers of trees are per hectare basis. Chir pine diameter distribution, grouped by density. Stem >10 cm are included.

Table 3. Distribution of Ground Flora in sampling area. Species are listed in decreasing order, number of stands in which a species was present. Summary of circular plots species from thirteen locations of *Pinus roxburghii* Sargent.

S. no.	Name of species	PRST	RF in stands (range)
1.	*Pinus roxburghii* Sargent	9	4.5-100
2.	*Dodonaea viscosa* (L.) Jacq	5	3.8-46
3.	*Punica granatum*, L.	5	2.2-17
4.	*Erodium cicutarium* (L.) L'Herit. Ex Ait.	4	2.2-7
5.	*Medicago denticulate* Willd.	4	5.2-11
6.	*Vicia sativa* L.	4	6.5-10.6
7.	*Aegopodium alpestre* Ledeb.	3	2.6-4.5
8.	*Allium griffithianum* Boiss.	3	4.3--9.3
9.	*Asplenium trichomanes*, L.	3	9.1-13
10.	*Indigofera gerardiana* Wall. Ex Baker	3	6-9.1
11.	*Micromeria biflora* (Ham.) Bth.	3	9.1-10.6
12.	*Rumex dentatus* L.	3	3.3-6
13.	*Rumex hastatus* D. Don.	3	7.5-9.7
14.	*Ajuga bracteosa* Wall. Ex Bth.	2	6.5-9
15.	*Berberis lycium*, Royle	2	4.1-9
16.	*Chrysopogon auchuri*, (Boiss) Stapf.	2	26-56
17.	*Cotoneaster nummularia*, Fisch.	2	9.1-18
18.	*Cotoneaster microphylla* Wall.	2	6.1-9
19.	*Ficus palmata* Forssk.	2	9.1-18
20.	*Mentha longifolia* (L.) Huds.	2	7.1-10.4
21.	*Monotheca buxifolia* (Falc.) Dcne. Ex Engler	2	1.9-2.7
22.	*Phalaris arundinacea* L.	2	3.8-5.2
23.	*Ranunculus sceleratus* L.	2	1.5-2
24.	*Scilla griffithii* Hochr.	2	3.9-4
25.	*Solanum surratense* Burn. f.	2	2.7-3
26.	*Targeonea hypophylla* (Herb Linn)	2	4.1-9
27.	*Tribulus terrestris* L.	2	3.7-3.8
28.	*Abutilon fruticosum* Guill. & Perr.	1	1.3
29.	*Acacia Arabica* (Lam.) Willd	1	2
30.	*Acacia modesta* Wall.	1	3.2
31.	*Aerva javanica* (Burm. f.) Juss.	1	2.6
32.	*Ailanthus altissima* (Mill.) Swingle	1	0.7

Table 3. (Cont'd.).

S. no.	Name of species	PRST	RF in stands (range)
33.	*Amaranthus viridis* Linn.	1	3.3
34.	*Artemesia maritima*, L	1	13
35.	*Artemisia brevifolia* Roxb.	1	4.5
36.	*Asparagus gracilis* Royle	1	2
37.	*Calendula arvensis* L.	1	1.6
38.	*Canabis sativa* L	1	9
39.	*Daphne mucronata* Royle	1	0.7
40.	*Fumaria indica* (Hausskn.) H.N.	1	4.5
41.	*Galium aparine* L.	1	5.3
42.	*Hetropogon contortus* (L.) P. Beauv. Ex Roem. & Sclult.	1	5.4
43.	*Indigofera heterantha*, Wall, ex Brand	1	13
44.	*Lantana camara* L.	1	23
45.	*Malvastrum coromandelianum* (L) Garacke	1	33
46.	*Marchantia polymorpha* L.	1	14
47.	*Melia azedarach* L.	1	0.7
48.	*Olea cuspadata* Wall. Ex DC.	1	1.1
49.	*Otostegia limbata* (Bth.) Bioss.	1	3
50.	*Phacelurus speciosus* (Steud) C.E. Hubbard.	1	44
51.	*Podophylum emodi*, Wallex Royle	1	43
52.	*Potentilla nepalensis* Hk.	1	0.7
53.	*Pteridium aquilinum*, (L.) Kuhn	1	9
54.	*Pteris cretica*, L. Mant	1	9
55.	*Pupalia lappacea*, (L.) Juss	1	22
56.	*Riccia sorocarpa* Bisch	1	16
57.	*Rubus ellipticus*, Smith	1	9
58.	*Salvia nubicola* Wall ex Sweet	1	6
59.	*Setaria glauca*, (L) P. Beauv	1	20
60.	*Solanum nigrum* L.	1	1.6
61.	*Tripogon filiformis*, Nees ex Steud	1	57
62.	*Urtica dioica* L.	1	2
63.	*Viola canescens* Wall. Ex Roxb	1	7.3

Note: PRST= Presence in number of stands, RF= Relative frequency (range) in stands. Species < 10 cm dbh are shown in this table.

Size frequency distribution of low density stands showed a flattened structure with some comparatively large trees and gaps. Gaps were defined as classes with less individual present than those on either side (Ahmed & Ogden, 1987). On the basis of disturbed nature and past cutting history of these forests, it may be suggested that gaps in these stands may be due to removal of the particular sized trees or no regeration in the past. This pattern of tree structure indicates inadequate recruitment (Knight, 1975) producing unstable population. Therefore it may be concluded that due to anthropogenic disturbances these forests are in unstable and in degrading stage therefore prompt conservation steps should be immediately taken to save these ecological and economically important forests and species.

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