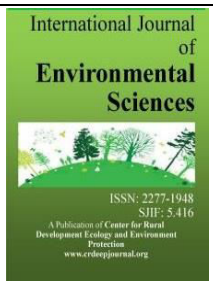
Vol. 8. No. 1. 2018.

Contents available at:

www.crdeepjournal.org

International Journal of Environmental Sciences (ISSN: 2277-1948)



Full Length Research Article

Plant Diversity Assessment and Prioritization of Communities for Conservation in Milam Alpine area of Nanda Devi Biosphere Reserve, West Himalaya

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ARTICLE INFORMATION

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Article history:
Received: 28-12-2018
Revised: 30-12-2018
Accepted: 03-01-2019

Key words:
Himalaya, Alpine Meadows, Species Diversity, Nativity, Endemism, Conservation, Prioritization

ABSTRACT

Alpine meadows of Indian Himalayan region (IHR) are very significant in terms of species diversity, nativity, endemism and occurrence of many high value plant species. These are the home of many rare endangered plant species. The uniqueness of the alpine meadows is due to its scenic beauty, topography and very harsh climatic conditions. Nanda Devi Biosphere Reserve (NDBR), a World Heritage Site is located in the northern part of west Himalaya. The reserve includes parts of Bageshwar and Pithoragarh districts in Kumaun region, and Chamoli district in Garhwal region. The reserve areas occupy a considerable area of alpine meadows. Present study has been conducted in the Milam alpine meadows, located in the Pithoragarh district of Uttarakhand, a part of NDBR. The study includes assessment of species richness, species diversity, community diversity, distribution of native, endemic, economically important and rare endangered species within the communities and prioritization of communities for conservation. During the study a total of 16 alpine communities have been delineated in the Milam alpine meadows of NDBR between 3470-4160m, amsl. Communities are supporting 226 species, distributed in 32 sites, 8 habitats. Based on the species richness, native, endemic, economically important and rare endangered species, prioritization of the communities for conservation has been done.

Introduction

Alpine meadows are located between the altitudinal tree line and the snow line. The alpine meadows are characterized by the presence of herbs, scattered shrubs, mosses and lichens (Billings, 1973; Rau, 1975). The alpine and subalpine grasslands have developed on relatively steep slopes at elevations where the climate is too cold and severe for tree growth (Yadava & Singh, 1977). The alpine region usually begins at 3000 m amsl and the snowline at 5000 m (Mani 1978).

The alpine zone occupies nearly 33% of geographical area in the Himalaya, of which the vegetated and snow-bound areas constitute about 25.88% and 7.22%, respectively (Anonymous, 1989). A total of 3,869 km^2 area is occupied by alpine meadows from the total 51,123 km^2 area of Uttarakhand, based on the satellite imagery interpretation. Of this total 1,291 km2 are in Kumaun and 2,578 km2 are in Garhwal. May be half of these totals are true meadows; the balance will be rocky poorer pastures (Gupta, 1979). Alpine meadows are also known as *Bugyal, Marg, Thach and Dhar* in the local languages throughout the Indian Himalayan Region. The alpine meadows are very rich in terms of floral diversity and the repository of native, endemic and rare endangered plants. Many high value medicinal plants are found in the alpine meadows, used to cure various diseases and ailments. About 2500 plant species have been reported from the alpine zones of the Greater Himalayas of which ca. 200 are highly endangered, over 100 are threatened, and 300 species are used for medicinal purposes (Rau, 1975). The meadows are an important source of food for wildlife and support a large livestock population maintained by migratory grazers in summer (Sahai & Kimothi, 1996 and Samant et al., 1996 a&b). Habitat degradation is the major concern of alpine meadows caused by overgrazing, camping of herders, collection of herbs for medicine and trade. Due to habitat degradation many potential species are degrading fast and over 8 species have been listed in the Red Data Book of Indian Plants (Nayar & Sastri, 1987, 88, 90; Samant et al., 1996a). Habitat degradation invites the invasion of alien species, which could affect the entire ecosystem of alpine meadows. Studies have been carried out on some aspects i.e. community patterns, phenology, biomass and productivity, impact of grazing and prioritization (Kaul & Sarin 1971; Rawat & Pangtey, 1987; Sundriyal et al., 1987, 1988; Rawat & Rodgers, 1988; Joshi et al., 1988; Joshi & Srivastava 1988, 1991; Ram, 1992; Ram et al., 1988, 1989; Sundriyal, 1989, 1992;

Singh, 1991; Singh et al., 1995, Negi et al., 1992, 1993; Rawat & Uniyal, 1993; Nautiyal et al., 1997; Rikhari et al., 1992; Johnsing et al., 1998; Kala et al., 1998; Kala & Rawat, 1999; Raizada et al., 1998, etc.). Keeping in view of the rich species diversity and the ecological significance of alpine meadows of Nanda Devi Biosphere Reserve the present study have been carried out on sites and habitat characteristics, community diversity (composition and structure), distribution pattern, species diversity, distribution pattern of native, endemic, economically important and rare endangered species, and prioritization of communities for conservation.

Materials and Methods

The Study Area

Nanda Devi Biosphere Reserve (NDBR) ($30^0$05'-$31^0$02'N to $79^0$12'-$80^0$19'E) covering a total of 6,407.03 km2 (Core zone 712.12 km2; Buffer zone 5,148.57 km2 and Transition zone 546.34 km2), is situated in the northern part of west Himalaya (Fig. 1) and is among the World Heritage Sites. The reserve includes parts of Bageshwar and Pithoragarh districts in Kumaun region, and Chamoli district in Garhwal region. The buffer and transition zones are inhabited by over 100 villages. Most of the inhabitants belong to two main ethnic groups namely Indo-Mongoloid (Bhotia) and Indo-Aryans. Present study has been conducted in the Milam alpine meadows, located in the Pithoragarh district of Uttarakhand, a part of NDBR.

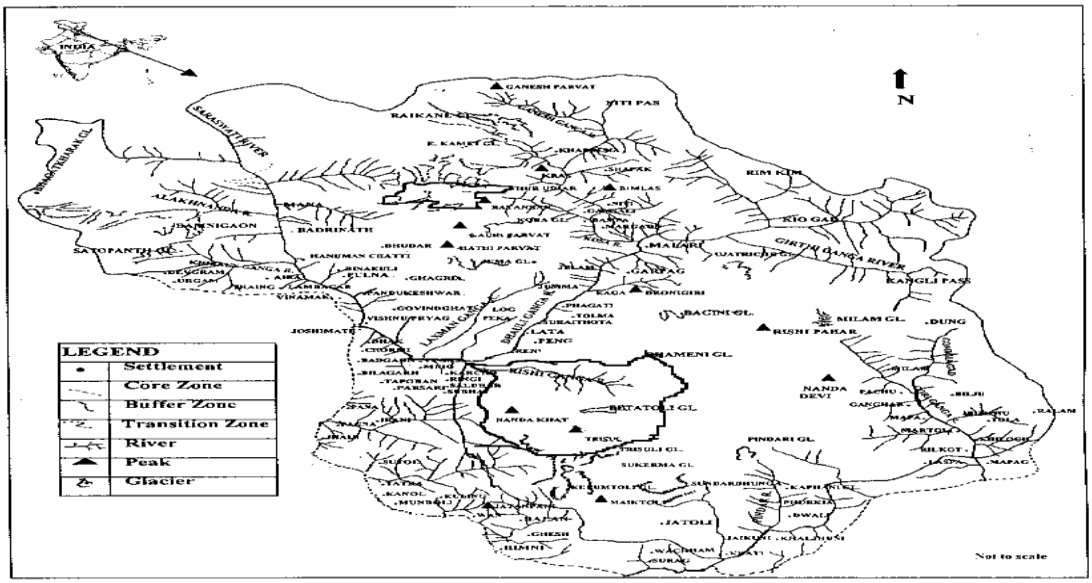

Fig 1. Location of Nanda Devi Biosphere Reserve. *(Prepared by Lead Office, GBPIHED, Kosi-Katarmal, Almora).*

Methods

Identification and selection of sites and habitats

For the sampling of vegetation, sites have been selected in each and every accessible aspect along transacts between 3470-4160m, amsl. In each site, habitat type, altitude, aspect, slope, boulder percentage and dominant species were noted. Habitats were identified on the basis of physical characters (Samant *et al*., 1998a). The sites having >50% boulders of the ground cover have been identified as bouldery habitat.

Survey, sampling, identification and analysis of data

The field surveys and samplings were carried out during the year 2000 within selected sites along transacts. For the sampling of vegetation 20x20m plot was marked in each site and 20 quadrats (1x1m) in each plot were laid down by stratified method. Data collection and vegetation analysis have been done by using standard ecological methods (Grieg-Smith, 1957; Kersaw, 1973; Muller-Dombois & Ellenberge, 1974; Dhar et al., 1997). Identification of collected plant specimens have been done with the help of florulas and research papers (Naithani, 1984 & 1985; Polunin & Stainton, 1984; Samant 1993, 1999; Pangtey et al., 1993; Hajra & Jain, 1981; and Hajra & Balodi, 1995). Abundance data of different sites were pooled to get community average in terms of density.

Community delineation, identification of nativity, endemism, human dependence and rarity

Communities have been delineated based on the 50% contribution of the total relative density of the species. Species of each community have been analyzed for nativity following (Anonymous, 1883-1970; Samant & Dhar, 1997 and Samant, 1999), endemism following (Dhar & Samant, 1993; Samant et al., 1998a&b; Samant & Dhar, 1997; and Samant, 1999), human dependence following (Samant et al. 1996a and Joshi et al., 1999), rarity following (Samant et al., 1996b, 1998b).

Species diversity (H')

Species diversity was determined by Shanon Wiener's information statistic (H') (Shanon Weiner, 1963).

Prioritization of communities for conservation

Prioritization of the communities for conservation has been done based on the cumulative values of species richness, native, endemic, economically important and rare-endangered species.

Results

Site and habitat characteristics

In Milam alpine meadows, maximum sites (6) have been represented by dry, and shrubberies, habitats, each, followed by bouldery (5 sites), shady moist and marsh wet land (4 sites, each), rocky (3 sites) and, camping site and riverine habitat (2 sites, each), respectively. Ten sites fall in W aspect, 8 in NW aspect, 6 in S aspect, four in SW aspect, 3 in N aspect and 1 in E aspect. The slope varied from 5°-65° and boulder percent from 5-55% (Table 1).

Table 1. Physical characteristics of sites and habitats in Milam alpine meadows

Site	Habitat type	Altitude (m)	Aspect	Slope (^{0})	Boulders %	Dominant species
1	Shrubberries	3900	NW	50	30	*Anaphalis contorta*, *Brachypodium sylvaticum*, *Thymus linearis*, *Potentilla fruticosa*
2	Shady moist	3940	SW	35	20	*Kobresia duthiei*, *Brachypodium sylvaticum*, *Anaphalis contorta*, *Polygonum affine*
3	Shrubberries	3980	NW	45	10	*Carex atrata*, *Saxifraga pulvinaria*, *Brachypodium sylvaticum*, *Carex haematostoma*
4	Shady moist	4060	NW	45	30	*Carex atrata*, *Polygonum affine*, *Bromus himalaicus*, *Poa alpina*
5	Rocky	4140	NW	65	0	*Kobresia duthiei*, *Potentilla fruticosa*, *Saxifraga pulvinaria*, *Polygonum affine*
6	Shrubberries	4140	NW	40	10	*Kobresia duthiei*, *Picrorhiza kurrooa*, *Polygonum affine*, *Dactylis glomerata*
7	Rocky,	4160	W	65	0	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Brachypodium sylvaticum*, *Dactylis glomerata*
8	Bouldery	3880	S	10	50	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Potentilla fruticosa*,*Calamogrostis emodensis*
9	Shrubberries	3850	E	35	10	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Brachypodium sylvaticum*, *Anaphalis nepalensis*
10	Camping site	3780	S	5	10	*Rumex nepalensis*, *Poa alpina*, *Carex stracheyi Calamagrostis emodensis*
11	Bouldery	3820	W	20	55	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Arenaria festucoides*,*Capsella bursa-pastoris*
12	Shady moist	3740	W	5	5	*Carex atrata*, *Brachypodium sylvaticum*, *Kobresia duthiei*, *Hedysarum kumaonense*
13	Shady moist	3750	N	5	10	*Carex atrata*, *Saxifraga pulvinaria*, *Brachypodium sylvaticum*, *Kobresia duthiei*
14	Dry	3780	W	45	5	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Brachypodium sylvaticum*, *Carex atrata*
15	Dry	3770	NW	45	10	*Danthonia cachemyriana*, *Anaphalis contorta*, *Calamagrostis emodensis*, *Carex nubigena*
16	Marsh-wet land	3740	N	5	5	*Juncus leucomelas*, *Poa alpina*, *Carex lehmanii*, *Poa pratensis*
17	Marsh-wet land	3740	W	5	5	*Poa alpina*, *Carex nubigena*, *Epilobium latifolium*, *Anemone rivularis*
18	Bouldery	3750	S	5	54	*Saxifraga pulvinaria*, *Danthonia cachemyriana*, *Anaphalis busua*, *Kobresia duthiei*
19	Marsh-wet land	3740	S	5	5	*Kobresia duthiei*, *Brachypodium sylvaticum*, *Carex obscura*,*Festucakashmiriana*
20	Bouldery	3760	N	5	54	*Kobresia duthiei*, *Anaphalis contorta*, *Brachypodium sylvaticum*, *Sibaldia cuneata*
21	Camping site	3830	W	5	5	*Rumex nepalensis*, *Carex obscura*,*Festucakashmiriana*, *Poa pratensis*
22	Dry	3550	W	50	10	*Danthonia cachemyriana*, *Agrostis munroana*, *Bromus japonicus*, *Bromus himalaicus*
23	Riverine	3540	W	30	20	*Ligularia amplexicaulis*, *Poa alpina*, *Calamagrostis emodensis*, *Lotus corniculatus*, *Brachypodium sylvaticum*, *Thymus linearis*, *Dactylis glomerata*, *Juncus himalensis*, *Oxyria digyna*
24	Riverine	3520	W	25	20	*Calamagrostis emodensis*, *Brachypodium sylvaticum*, *Trigonella emodi*, *Melica persica*, *Carex obscura*, *Chrysosplenium tenellum*
25	Dry	3600	NW	40	5	*Danthonia cachemyriana*, *Bromus himalaicus*, *Saxifraga pulvinaria*, *Arenaria festucoides*
26	Dry	3740	W	45	5	*Danthonia cachemyriana*, *Arenaria festucoides*, *Carex stracheyi*, *Anaphalis contorta*
27	Bouldery	3750	SW	20	53	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Carex nubigena*, *Arenaria festucoides*
28	Dry	3720	NW	60	5	*Danthonia cachemyriana*, *Saxifraga pulvinaria*, *Melica persica*, *Arenaria festucoides*
29	Marsh-wet land	3630	SW	35	5	*Chrysanthemum indicum*, *Carex obscura*, *Carex setosa*, *Calamagrostis emodensis*
30	Rocky	3510	S	60	0	*Danthonia cachemyriana*, *Arenaria serpylifolia*, *Thymus linearis*, *Aster falconerii*
31	Shrubberries	3800	S	50	10	*Agrostis pilosula*, *Carex haematostoma*, *Poa alpina*, *Thymus linearis*
32	Shrubberries	3470	SW	30	20	*Thymus linearis*, *Calamagrostis emodensis*, *Anaphalis contorta*, *Melica persica*

Community diversity, distribution pattern and species composition

A total of 16 alpine communities have been delineated in the Milam alpine meadows of NDBR between 3470-4160m, amsl. The community types, altitudinal distribution, representation in site/s, habitat/s and major associates have been presented in Table 2. *Danthonia cachemyriana* was represented in maximum (8 sites), followed by *Carex atrata*, *Danthonia cachemyriana-Saxifraga pulvinaria*, *Kobresia duthiei*,(4 sites, each), communities whereas the remaining communities represented in one site only (Table 2).

In general, a total of 226 species (24 shrubs, 102 herbs including 6 pteridophytes) have been recorded from Milam alpine meadows. However, 219 species (24 shrubs, 195 herbs including 6 pteridophytes) had been recorded in the sampling sites. Analysis of distribution pattern of species indicated that in the Milam alpine meadows 87.69% species had regular distribution pattern; 5.64% species had random distribution pattern; and 6.67% species had contagious distribution pattern among the sites; and 84.62% species had regular distribution pattern; 8.72% species had random distribution pattern; and 6.67% species had contagious distribution pattern among the communities.

Table 2. Community types, their distribution and major associates in Milam alpine meadows

Community type	SR	Habitat type/s	Altitudinal range (m)	Major associates
Agrostis pilosula-Carex haematostoma-Poa alpina mixed	1	9	3800	*Thymus linearis*, *Artemisia maritima*, *Calamagrostis emodensis*, *Carex alpina*
Anaphalis contorta-Brachypodium sylvaticum-Thymus linearis mixed	1	9	3900	*Calamagrostis emodensis*, *Potentilla fruticosa var. rigida*, *Polygonum affine*,*Eritrichlum canum*
Calamagrostis emodensis mixed	1	6	3520	*Kobresia duthiei*, *Arenaria festucoides*, *Galium asperifolium*, *Carex stracheyi*
Carex atrata	4	8, 9	3740-4060	*Saxifraga pulvinaria*, *Brachypodium sylvaticum*, *Kobresia duthiei*, *Polygonum affine*
Chrysanthemum indicum-Carex obscura-Carex setosa mixed	1	5	3630	*Calamagrostis emodensis*, *Agrostis munroana*,*Festucakashmiriana*, *Gentianella peduncularis*
Danthonia cachemyriana	8	1, 3, 7	3510-4160	*Saxifraga pulvinaria*, *Arenaria festucoides*, *Agrostis munroana*, *Bromus himalaicus*
Danthonia cachemyriana-Saxifraga pulvinaria mixed	4	1, 3, 9	3720-3880	*Potentilla fruticosa var. rigida*, *Brachypodium sylvaticum*, *Arenaria festucoides*, *Thymus linearis*
Juncus leucomelas-Poa alpina *mixed*	1	5	3740	*Carex lehmanii*, *Poa pratensis*, *Carex haematostoma*, *Kobresia duthiei*
Kobressia duthiei	4	5, 7, 8, 9	3740-4140	*Brachypodium sylvaticum*, *Saxifraga pulvinaria*, *Potentilla fruticosa var. rigida*, *Polygonum affine*
Kobressia duthiei-Anaphalis contorta mixed	1	1	3760	*Brachypodium sylvaticum*, *Sibaldia cuneata*, *Thymus linearis*, *Carex stracheyi*
Ligularia amplexicaulis mixed	1	6	3540	*Anaphalis contorta*, *Galium acutum*, *Origanum vulgare*, *Lomatogonium carinthiacum*
Poa alpina-Carex nubigena-Epilobium latifolium mixed	1	5	3740	*Anemone rivularis*, *Aster diplostephioides*, *Dactylis glomerata*, *Potentilla fruticosa var. Rigida*
Rumex nepalensis-Carex obscura mixed	1	2	3830	*Festucakashmiriana*, *Poa pratensis*, *Geranium wallichianum*, *Artemisia maritima*
Rumex nepalensis-Poa alpina-Carex stracheyi-Calamagrostis emodensis mixed	1	2	3780	*Brachypodium sylvaticum*, *Poa pratensis*, *Geranium wallichianum*, *Artemisia gmelinii*
Saxifraga pulvinaria	1	1	3750	*Danthonia cachemyriana*, *Anaphalis busua*, *Kobresia duthiei*, *Brachypodium sylvaticum*
Thymus linearis-Calamogrostis emodensis-Anaphalis contorta- Melica persica mixed	1	9	3470	*Bupleurum falcatum*, *Brachypodium sylvaticum*, *Thalictrum chelidonii*, *Heracleum brunonis*

Abbreviations used: *SR=Site representation;1= Bouldery; 2= Camping site; 3= Dry; 5= Marsh-wet land; 6= Riverine; 7= Rocky; 8= Shady moist; 9= Shrubberries*

Community diversity: composition and structure

In general, the richness among the communities in Milam alpine meadows ranged from 10-124. It was highest in *Danthonia cachemyriana* (124), followed by *Carex atrata* (64), *Kobresia duthiei* (64), and *Danthonia cachemyriana- Saxifraga pulvinaria* mixed (53), communities (Table 3). The herb density, ranged from 44.65-617.31 Ind m^{-2}. *Danthonia cachemyriana* community had maximum density (617.31 Ind m^{-2}), followed by *Saxifraga pulvinaria* (521.10 Ind m^{-2}), *Danthonia cachemyriana- Saxifraga pulvinaria* mixed (501.55 Ind m^{-2}) and *Kobresia duthiei* (413.89 Ind m^{-2}), communities (Table 3).

Species diversity (H')

Species diversity H' in Milam alpine meadows ranged from 1.30-3.32. The H' was highest in *Ligularia amplexicaulis* mixed community (3.32), followed by *Calamagrostis emodensis* mixed (3.03) and *Poa alpina*, *Carex nubigena*, *Epilobium latifolium* mixed (2.42) and *Agrostis pilosula-Carex haematostoma-Poa alpina mixed* (2.40), communities (Table 3).

Table 3. Community wise distribution of species richness, total density and species diversity of Milam alpine meadows

S.N.	Community type	Species richness	Total density (Ind m^{-2})	Diversity (H')
1	*Agrostis pilosula-Carex haematostoma-Poa alpina* mixed	22	119.55	2.40
2	*Anaphalis contorta-Brachypodium sylvaticum-Thymus linearis* mixed	16	92.80	2.33
3	*Calamagrostis emodensis* mixed	35	165.50	3.03
4	*Carex atrata*	64	319.50	1.96
5	*Chrysanthemum indicum-Carex obscura-Carex setosa* mixed	22	152.75	2.16
6	*Danthonia cachemiriana*	124	617.31	1.30
7	*Danthonia cachemyriana-Saxifraga pulvinaria* mixed	53	501.55	1.80
8	*Juncus leucomelas-Poa alpina* mixed	18	214.55	1.99
9	*Kobresia duthiei*	64	413.89	1.35
10	*Kobresia duthiei-Anaphalis contorta* mixed	24	116.70	2.30
11	*Ligularia amplexicaulis* mixed	36	172.40	3.32
12	*Poa alpina-Carex nubigena-Epilobium latifolium* mixed	19	106.30	2.42
13	*Rumex nepalensis-Carex obscura* mixed	10	44.65	1.82
14	*Rumex nepalensis-Poa alpina-Carex stracheyi-Calamagrostis emodensis* mixed	13	60.20	2.13
15	*Saxifraga pulvinaria*	20	521.10	1.39
16	*Thymus linearis-Calamagrostis emodensis-Anaphalis contorta-Melica persica* mixed	14	50.75	2.22

Distribution pattern of the native and endemic species within communities

In Milam alpine meadows, out of total 226 species, 66.81 % species were natives. Among the natives, 3.31 % species were endemic and 51.66% species were near endemic and, rest 45.03% species had wide global distribution. Of the natives, 86.75% species were herbs and 13.25% species were shrubs. Endemic species were represented in herbs only whereas near endemic species were represented in both the life forms. Among the near endemic species, 85.90% species were herbs and 14.10% species were shrubs.

The distribution of native and endemic species including near endemic ones within the identified communities from Milam alpine meadows have been presented in Fig. 2 a & b. The maximum natives (81 spp.) were found in *Danthonia cachemyriana* community, followed by *Carex atrata* (45 spp.), *Kobresia duthiei* (42 spp.) and *Danthonia cachemyriana - Saxifraga pulvinaria* mixed (39 spp.), communities. The least natives (5 spp.) were recorded in *Poa alpina-Carex nubigena-Epilobium latifolium* mixed and *Rumex nepalensis-Carex obscura* mixed, communities, each.*Danthonia cachemyriana* community had the maximum endemic species including near endemic ones (40spp.), followed by *Carex atrata* (26 spp.) and *Kobresia duthiei* (19 spp.), communities.

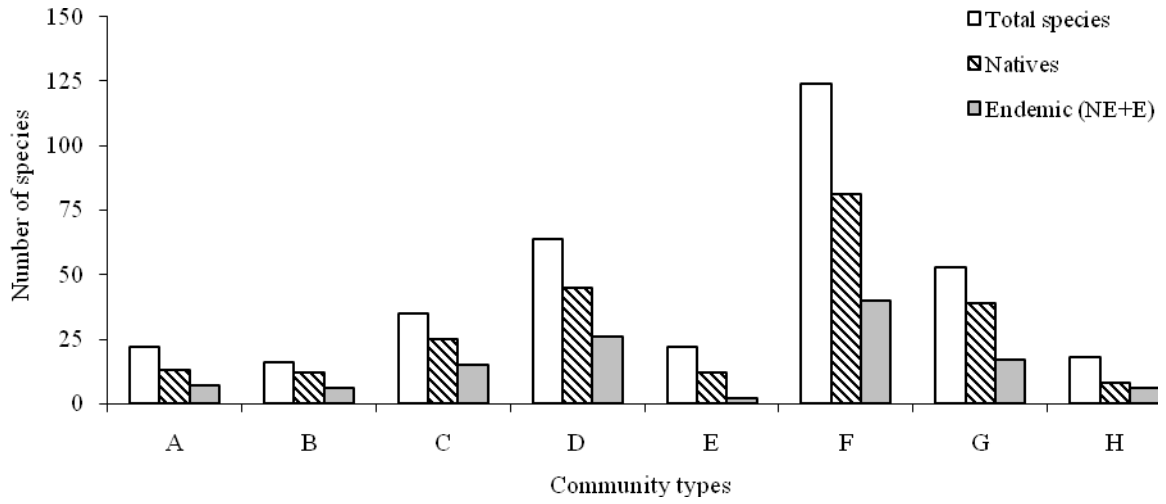

Fig. 2 a. Distribution of native and endemic species in alpine communities of Milam alpine meadows

Abbreviations used (Community types A-H): *A=Agrostis pilosula-Carex haematostoma-Poa alpina mixed; B=Anaphalis contorta-Brachypodium sylvaticum-Thymus linearis mixed; C=Calamagrostis emodensis mixed; D=Carex atrata; E=Chrysanthemum indicum-Carex obscura-Carex setosa mixed; F=Danthonia cachemyriana; G=Danthonia cachemyriana-Saxifraga pulvinaria mixed; and H=Juncus leucomelas-Poa alpina mixed*

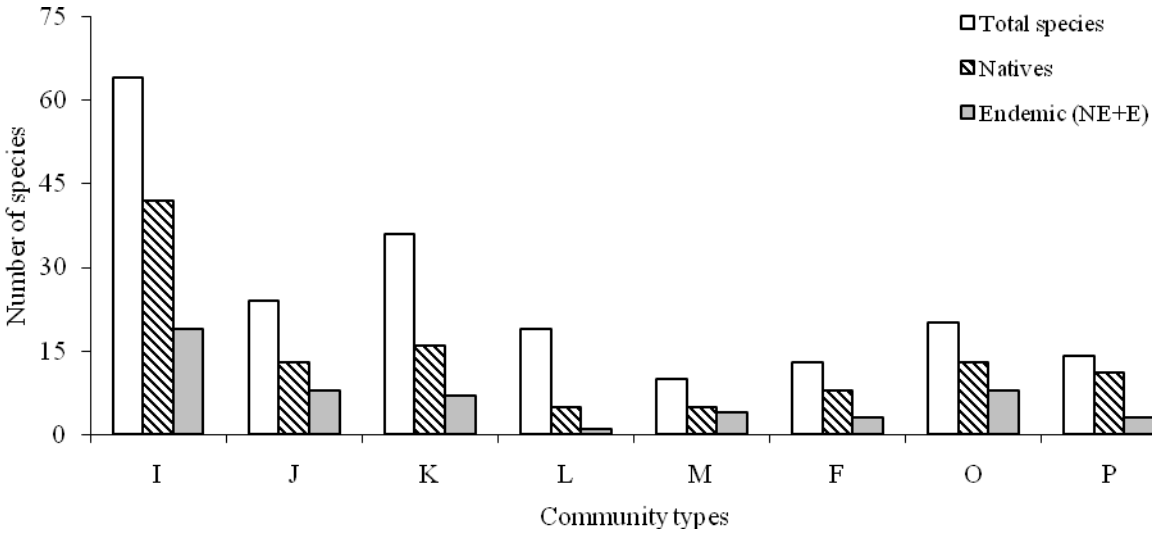

Fig. 2 b. Distribution of native and endemic species in alpine communities of Milam alpine meadows

Abbreviations used (Community types I-P): *I=Kobresia duthiei; J=Kobresia duthiei-Anaphalis contorta mixed; K=Ligularia amplexicaulis mixed; L=Poa alpina-Carex nubigena-Epilobium latifolium mixed; M=Rumex nepalensis-Carex obscura mixed; N=Rumex nepalensis-Poa alpina-Calamogrostis emodensis-Carex stracheyi mixed; O=Saxifraga pulvinaria; and P=Thymus linearis-Calamagrostis emodensis-Anaphalis contorta-Melica persica mixed*

Distribution pattern of the economically important species within communities

From the Milam alpine meadows, 119 economically important species (16 shrubs, 103 herbs including 1 pteridophyte) belonging to 40 families and 85 genera have been recorded. These species were used in a variety of purposes such as medicine (78 spp.), wild edible/food (37 spp.), fodder (52 spp.), fuel (6 spp.), religious (9 spp.) and various other purposes (13 spp.). Amongst the species, 18 species had multipurpose utility whereas 67 species had single utility. In Milam alpine meadows, the richness of economically important species among the identified communities ranged from 7-63. The highest useful species were distributed in *Danthonia cachemyriana* (63 spp.), *Carex atrata* (36 spp.), *Kobresia duthiei* (31 spp.), *Danthonia cachemyriana-Saxifraga pulvinaria* mixed (29 spp.) and *Ligularia amplexicaulis* mixed (27 spp.), communities. The least economically important species were distributed in *Rumex nepalensis-Carex obscura* mixed (7 spp.), community.

Distribution pattern of the rare endangered species within communities

A total of 42 species belonging to 30 genera and 22 families have been identified as threatened species from Milam alpine meadows. Maximum rare species were distributed in *Danthonia cachemyriana* community (20 spp.), followed by *Kobresia duthiei* (11 spp.), *Carex atrata* (9 spp.) and *Danthonia cachemyriana-Saxifraga pulvinaria* mixed (8 spp.), communities.The least rare species were distributed in *Rumex nepalensis-Poa alpina-Calamagrostis emodensis-Carex stracheyi* mixed *and Thymus linearis-Calamagrostis emodensis-Anaphalis contorta-Melica persica* mixed (1 spp., each), communities. In *Anaphalis contorta-Brachypodium sylvaticum-Thymus linearis* mixed and *Poa alpina-Carex nubigena-Epilobium latifolium* mixed, communities the rare species were absent.

Prioritization of communities for conservation

Based on the species richness, native, endemic, economically important and rare endangered species in Milam alpine meadows, *Danthonia cachemyriana* (Total species 124; Natives 81; Endemic 40; Rare-endangered 20; Useful species 63); *Carex atrata* (Total species 64; Natives 45; Endemic 26; Rare-endangered 9; Useful species 36); and *Kobresia duthiei* (Total species 64; Natives 42; Endemic 19; Rare-endangered 11; Useful species 31), communities have been identified as high value communities and merit priority attention for conservation.

Discussion

In past, studies have been carried out by several workers on floristics, vegetation composition, species diversity, structural and functional diversity, human dependence, resource utilization pattern, nativity, endemism and rarity separately. The present study have integrated the composition, structural and functional diversity, human dependence, nativity, endemism, and rarity of the species. The aim of the study is to prioritize habitats, species and communities for conservation. The characteristic feature of the alpine vegetation is the dominance of tussuck forming grasses and cushion and spreading forbs. These species cover the maximum part of the alpine meadows. Similar distribution of the species has been also noted in the present study and also, by earlier workers (Ram, 1988; Kala et al., 1998) in other alpine meadows of the west Himalaya.

The alpine meadows of the NDBR are located in the remote areas, and are not connected with roads. Further, the human dependence on plant resources in the alpine zones is comparatively negligible due to distant locations and inaccessibility compared to the subtropical and temperate zones. The harsh climatic conditions are also not suitable for the establishment of seeds of non-native species in the area. Hence, the nativity is very high compared to subtropical and temperate zones (Samant et al., 1998).

In the present study, identification of 16 communities 190 species from Milam alpine meadows indicates that the alpine meadows have a rich diversity of communities and species. The above communities have been identified for the first time in these areas. A significant positive relationship had been found between the number of useful species and number of rare species in Milam alpine meadows i.e., ($r=0.480$, $p<0.01$ $n=32$) (Fig. 6.1 a-d) indicating that the use of the species was directly proportional to the rarity of the species (Fig. 3). A correlation between species

richness and native species had been found positive for Milam alpine meadows i.e., (r=0.903, p<0.01 n=32) (Fig. 4).

Based on the species richness, native, endemic, economically important and rare endangered species in Milam alpine meadows, *Danthonia cachemyriana* (Total species 124; Natives 81; Endemic 40; Rare-endangered 20; Useful species 63); *Carex atrata* (Total species 64; Natives 45; Endemic 26; Rare-endangered 9; Useful species 36); and *Kobresia duthiei* (Total species 64; Natives 42; Endemic 19; Rare-endangered 11; Useful species 31), communities have been identified as high value communities and merit priority attention for conservation.

The habitat degradation and overexploitation of the economically important native species such as *Aconitum heterophyllum*,*Dactylorhiza hatagirea*,*Arnebia benthamii*, *Picrorhiza kurrooa*, *Nardostachys grandiflora*,*Saussurea obvallata*, *Rheum spiciforme*, etc., had caused population depletion to a great extent in the wild. Continuous overexploitation of such species may lead to their early extinction from their natural habitats. Therefore, timely human interventions for the conservation of these species are urgently required.

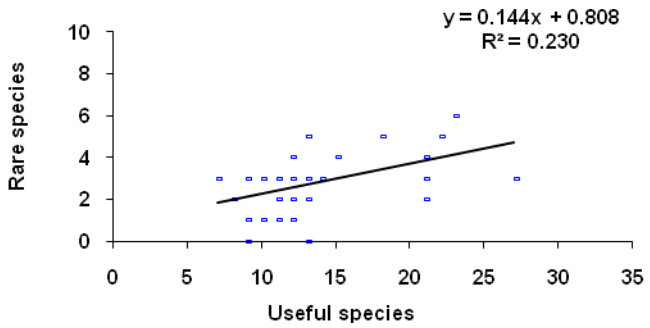

Fig 3. Correlation between numbers of useful species with number of rare species in Milam alpine meadows.

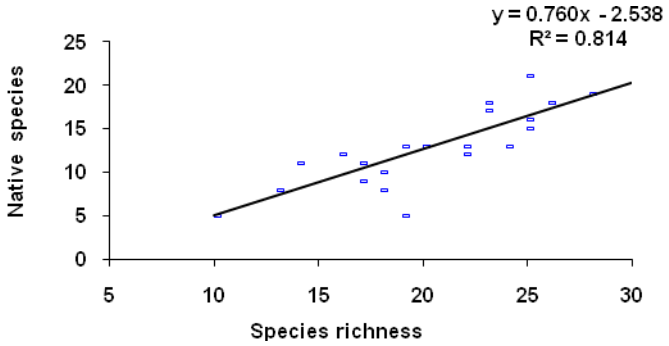

Fig. 4. Correlations between species richness and native species in Milam alpine meadows.

Conclusion

The present study conducted in Milam alpine meadows of NDBR provides data base on compositional and structural, distribution pattern of species, communities, native, endemic and rare-endangered species within different communities. Occurrence of 16 alpine communities and 226 species in the study area suggested its importance from the point view of conservation. Due to the habitat degradation and over exploitation many economically important plant species are depleting very fast. Therefore, urgent steps has to be taken for the conservation of these species. Keeping in view the rich biodiversity of alpine meadows it is pertinent to make an appropriate strategy and action plan for the conservation and management of habitats, communities and ecosystems, supporting high value species.

Acknowledgements

The authors are thankful to the Director of the Institute for facilities and encouragement. Help received from Dr. H.C. Joshi during field surveys and preparation of the paper, Dr. K.K. Kothari, Mr. S. Pant and Mr. B.M. Joshi during the preparation of this paper is highly acknowledged. Ministry of Environment & Forests, New Delhi and Council of Scientific and Industrial Research, New Delhi, are greatly acknowledged for financial assistance.

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