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Floristic Diversity in Alpine Pasture of Mural Danda of District Shimla, Himachal Pradesh

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ABSTRACT: The alpine pastures are mainly found in the Himalayan states and supposed to be only true grasslands in India. Due to unscientific management of pastures, a large number of pasture lands had been converted or are in the process of conversion to the degraded lands thereby bringing a shift in the natural equilibrium and plant diversity as well. In this scenario, it has become quite pertinent to carry out the ecological studies of these precious resources for assessing the loss in diversity and their scientific management. Accordingly studies to evaluate the floristic diversity and growth forms in alpine pasture of Mural Danda of district Shimla, Himachal Pradesh was conducted during August, 2019. Phyto-scociological studies was carried out by laying out quadrates randomly in the selected alpine pasture. The data collected was analyzed for density, frequency, abundance, important value index, dominance index, diversity index, distribution pattern, life forms etc for drawing the logical conclusion. Total numbers of plant species were 82 belonging to 70 genera and 34 families. The plant species comprised of 5 grasses, 1 sedge, 2 leguminous forbs and 74 non leguminous forbs. On the basis of Importance Value Index (IVI), *Iris kemaonensis* recorded the highest value (15.86) followed by *Anaphalis contorta* (12.44) and *Trifolium repens* (11.02). The distribution pattern of most of the species was contiguous. The value of dominance index, diversity index, richness index and evenness index was 0.021, 4.17, 10.203 and 0.946 respectively. The contribution of tall forbs, short forbs and cushioned and spreading forbs in the alpine pasture was 41.46%, 52.44% and 6.10% respectively. Out of 48 medicinal plant species found in the studied alpine pasture, 9 species viz., *Aconitum heterophyllum, Bergenia stracheyi, Malaxis muscifera, Meconopsis aculeata, Polygonatum multiflorum, Polygonatum verticillatum, Roscoea alpina* and *Selinum tenuifolium* fall in the category of threatened plant species.

Keywords: Dominance, Diversity index, distribution, Threatened plant.

INTRODUCTION

The alpine regions mainly fall in the great Himalayan, ranges and characterized with relatively low atmospheric pressure, invariably associated with low temperature, intense insulation, rapid and high ultra violet (UV) radiations along with their related effects as chain reactions. All these factors are closely and inseparably inter-linked and intricately intertwined in a complex chain of causes and effects thus constituting in reality, a self-regulating dynamic system termed as the alpine ecosystem. The plants in alpine region are in harmony with environment because they form the integral part of very processes that shaped their own environment. These plants are recognized by certain super- imposed morphological and taxonomic peculiarities, which form part of their adaptation to alpine environment.

The pastures in the alpine zone occupy about 1.52 per cent of the total land area in the country and are mainly concentrated in the Himalayan states of Arunachal Pradesh, Sikkim, Uttar Pradesh, Himachal Pradesh and Jammu & Kashmir. The total geographical area of Himalayan land in India is 61.5 million ha, out of which, 17.8 million ha is covered by alpine pastures usually found at an altitude above 2800 m and where climate is not helpful for growth of any trees. The alpine pastures are supposed to be the only true grasslands in India and where the grazing density is too high with approximately 20 million cattle, 10 million buffaloes, 3 million sheep and 6 million goats grazing here. Due to high level of this degradation, the present level of grass production of the Himalayan grasslands is about 25 percent - even less than that of their possible potential. As far as Himachal Pradesh is concerned, alpine pastures cover around 10,052 sq km which otherwise constitute 17 percent of the total geographical

area of the state. Floristic composition, diversity of the species and phytosociological studies are useful elements of the ecosystems. Large number of pasture lands have been converted or are in the process of conversion to degraded areas due to lack to proper management practices. Little attention has been given to the alpine pasture for their scientific management. The present study was carried out to know the status of plant species diversity of alpine pasture which could be useful in diversity strategies for their better management.

MATERIALS AND METHODS

The study was conducted in alpine pasture of Mural Danda area of district Shimla, Himachal Pradesh during August, 2019 between 3245m to 3750m elevation range. The site lies at 31°18'42.9" to 31°19'41.7" N latitude and 77°44'56.0" to 77°45'11.7" E longitude. Phytosociological study was carried out by laying out the quadrats of size 1mx1m randomly in the alpine pasture. The vegetation data was analyzed for density, frequency and abundance as per Curtis and McIntosh (1950). The relative values of density, frequency and dominance was summed to get Importance Value Index (IVI) of individual species. The abundance to frequency ratio (A/F) of different species was determined for eliciting the distribution pattern of the floral elements. This ratio indicates regular (<0.025), random (0.025 to 0.050) and contiguous (>0.050) distribution (Curtis and Cottam, 1956). The plant species diversity was calculated following Shannon-Wiener diversity Index (H) (Shannon-Wiener, 1963).

$$H = -\sum_{i=1}^{S} (Ni/N) \ln (Ni/N)$$

Dominance Index (C) was measured by Simpson's Index (Simpson, 1949).

$$C = \sum_{i=1}^{S} (Ni/N)^2$$

Where Ni = Importance value of species i and N= Total importance value of all the species.

Richness Index was estimated as per Margalef (1958) *i.e.*, R = S-1/ln N

Evenness Index was calculated as per Hill (1973) *i.e.*, E = H/ ln S

Where S= Total number of species, N= Total number of individuals of all the species, H = Index of diversity, ln= Natural log.

The different plant categories *viz.*, grasses, sedges, leguminous and non-leguminous forbs were recognized and then species were assigned to various growth forms following Santvan (1993). The growth forms indicates tall forbs (>30 cm height), short forbs (<30 cm height) and cushion and spreading forbs. The plants of medicinal values along with threatened category were also documented from the studied site.

RESULTS AND DISCUSSION

Total number of plant species was 82 belonging to 70 genera and 34 families. The dominant families were Asteraceae, Caryophyllaceae, Fabaceae, Lamiaceae, Poaceae and Polygonaceae. The plant species comprised of 5 grasses, 1 sedge, 2 leguminous forbs and 74 non-leguminous forbs was recorded. The grasses comprised of *Agrostis munroana, Agrostis pilosula, Cynodon dactylon, Poa alpina* and *Poa annua.* The sedge consisted of *Cypress squarrosus* while leguminous forbs comprised of *Trifolium pretense* and *Trifolium repens.* The non leguminous forbs comprised of *Anaphalis contorta, Anemone obtusiloba*, *Bergenia stracheyi, Sibbaldiac uneata, Geranium wallichianum, Plantago lanceolata, Ranunculus brotherusii, Pleurospermum brunoni, Thymus linearis* and *Tanacetum dolichophyllum* etc. *Anaphalis contorta* was the dominant species having highest value for density (4.83 m^{-2}) and abundance (18.13). This was followed by *Trifolium repens* (4.53 m^{-2}) in term of density. In case of frequency, *Trifolium repens* recorded the maximum value (93.33). On the basis of IVI, *Iris kemaonensis* recorded the highest value (15.86) followed by *Anaphalis contorta* (12.44) and *Trifolium repens* (11.02). The community identified was *Iris kemaonensis- Anaphalis contorta* in this site. The plant communities are never static but are always in a changing state and their studies are of great significance for management of grassland providing valuable information on the diversity and dominance of constituent species of the communities (Santvan, 1993). Billings (1978) while studying the alpine vegetation found it most susceptible to human and animal damage through trampling, camp sites, proliferation of trails which result in exposing soil and in irreversible ecosystem changes and extinction of certain species. The A/F ratio indicates that the distribution pattern of most of the species was contiguous. However, some species showed random distribution. The general preponderance of contiguous distribution in vegetation has been reported by several workers (Kershaw, 1973; Singh and Yadava, 1974; Kunhikannan *et al*., 1998) while working in different ecosystem.

The species present in alpine pasture were analyzed for different growth form classes and the contribution of all forbs, short forbs, cushion and spreading forbs was 41.46%, 52.44% and 6.01% to the total flora. The results are in conformity with the earlier studies made by Singh (1967); Santvan (1993); Verma *et al.* (2008).

In the present study, 41.46 % tall forbs, 52.44 % short forbs and 6.10% cushion and spreading forbs were observed. Similar findings were reported by different workers while conducted the study in alpine pasture. Santvan (1993) for the alpine pasture near Rahla, reported 22.5% tall forbs, 45.0% short forbs and 32.5% cushion and spreading forbs.

Verma *et al*. (2008) recorded 29.33% tall forbs, 54.66% short forbs and 16.0% cushion and spreading forbs for alpine pasture of Talra, Himachal Pradesh. The short forbs usually have hairy leaves which protect them against frost. The cushion and spreading forbs are characterized by various adaptive features such as leaf rosettes, dense cushion, hairy growth etc. which provide relative protection against the harsh conditions of alpine environment. The annuals form a major component in the alpine and high sub alpine environment. It is difficult for most species to complete the entire life cycle in a single cold growing season (Bliss, 1971; Saville, 1972; Santvan, 1993; Verma *et al*., 2008).

Total 31 unpalatable plant species have been recorded from the studied alpine pasture by compiling with Kaur *et al.* (2010); Singh *et al.* (2017). Some of these are *Achillea millefolium, Aconogonum molle, Anaphalis contorta, Anemone obtusiloba, Anemone tetrasepala, Artemisia parviflora, Chaerophyllum reflexum, Cirsium falconeri, Crawfurdia speciosa, Cynoglossum micranthum, Delphinium cashmerianum, Erigeron multiradiatus, Impatiens sulcata, Iris kemaonensis, Ligularia amplexicaulis, Meconopsis aculeata, Morinalongiflora, Pedicularis pyramidata, Pimpinella diversifolia, Primula denticulata, Primula glomerata, Rumex acetosa, Rumex nepalensis, Salvia nubicola, Selinum tenuifolium, Senecio graciliflorus, Swertia purpurascens, Tanacetum dolichophyllum* and *Verbascum thapsus* are mainly characteristic species of the camping sites or around the deras of the graziers where the organic matter was found accumulated due to excretory wastes of the animals (Verma *et al.*, 2006; Nautiyal and Kaechole, 2006; Verma *et al*., 2008; Kaur *et al*., 2010; Arya and Samant (2017). The unpalatable plant species occurred throughout the alpine pastures, however, their occurrence was more around the deras of the graziers.

Table 1: Phytosociological attributes of the herb species in alpine pasture of Mural Danda, District Shimla, Himachal Pradesh.

Species	Density (m^{-2})	Frequency (%)	Abun-dance	A/F	IVI	Growth Form	Palatable /Unpalatable Species
Grasses							
Agrostis munroana Aitch. &Hemsl.	1.43	36.67	3.91	0.107	3.80	**TF**	**PA**
Agrostis pilosula Trin.	2.50	50.00	5.00	0.100	5.38	**TF**	**PA**
Cynodon dactylon (L.) Pers.	1.50	53.33	2.81	0.053	4.26	**CS**	**PA**
Poa alpina L.	4.07	40.00	10.17	0.254	7.96	**SF**	**PA**
Poa annua L.	2.50	83.33	3.00	0.036	6.85	**SF**	**PA**
Sedges							
Cyperus squarrosus L.	1.07	36.67	2.91	0.079	3.24	**SF**	**PA**
Leguminous Forbs							
Trifolium pratense L.	4.00	73.33	5.45	0.074	8.61	**CS**	**PA**
*Trifolium repens*L.	4.53	93.33	4.86	0.052	11.02	**CS**	**PA**
Non Leguminous Forbs							
Achillea millefolium L.	2.83	13.33	21.25	1.594	5.90	**SF**	**UP**
Aconitum heterophyllum Wall. ex Royle	1.20	20.00	6.00	0.300	2.84	**TF**	**PA**
Aconogonum molle (D. Don) Hara.	0.63	10.00	6.33	0.633	1.72	**TF**	**UP**
Adiantum edgeworthii Hook.	0.97	40.00	2.42	0.060	4.75	**SF**	**PA**
Allium humile Kunth	0.63	30.00	2.11	0.070	2.51	**SF**	**PA**
Anaphalis contorta (D.Don) Hook.f.	4.83	26.67	18.13	0.680	12.44	**SF**	**UP**
Anemone obtusiloba D.Don	4.07	50.00	8.13	0.163	9.84	**SF**	**UP**
Anemone tetrasepala Royle	3.17	50.00	6.33	0.127	8.59	**SF**	**UP**
Ainsliaea latifolia (D.Don.) Sch. Bip.	1.00	26.67	3.75	0.141	2.81	**SF**	**PA**
Artemisia parviflora Roxb. ex D.Don	2.67	53.33	5.00	0.094	9.03	**TF**	**UP**
Bergenia stracheyi (Hook.f. & Thomson) Engl.	0.50	10.00	5.00	0.500	1.38	**SF**	**PA**
Bistorta amplexicaulis (D. Don) Greene	0.27	6.67	4.00	0.600	0.83	**TF**	**PA**
Chaerophyllum reflexum Aitch.	0.50	13.33	3.75	0.281	1.46	**TF**	**UP**
Cicerbita macrorhiza (Royle) Beauverd	0.33	6.67	5.00	0.750	1.13	**SF**	**PA**
Cirsium falconeri (Hook.f.) Petr.	0.40	13.33	3.00	0.225	2.10	**TF**	**UP**
Corydalis govaniana Wall.	0.53	20.00	2.67	0.133	1.88	**SF**	**PA**
Crawfurdia speciosa Wall.	0.17	6.67	2.50	0.375	0.77	**SF**	**UP**
Cynoglossum micranthum Desf.	0.40	16.67	2.40	0.144	2.25	**TF**	**UP**
Delphinium cashmerianum Royle	0.37	20.00	1.83	0.092	1.57	**SF**	**UP**
Diplazium esculentum (Retz.) Sw.	0.53	26.67	2.00	0.075	2.51	**TF**	**PA**
Epilobium laxum Royle.	0.67	13.33	5.00	0.375	1.84	**TF**	**PA**
Erigeron multiradiatus (Lindl. ex DC.)	0.63	13.33	4.75	0.356	2.42	**SF**	**UP**

Benth. ex C.B.Clarke							
Fragaria nubicola (Lindl. Ex Hook.f.) Lacaita	2.30	30.00	7.67	0.256	4.83	**CS**	**PA**
Gentiana depressa D.Don	0.63	23.33	2.71	0.116	2.14	**SF**	**PA**
Geranium wallichianum D. Don. ex.Sweet.	1.07	30.00	3.56	0.119	3.64	**SF**	**PA**
Gerbera gossypina (Royle) Beauverd	0.40	20.00	2.00	0.100	1.58	**SF**	**PA**
Geum elatum Wall. ex G. Don.	1.00	16.67	6.00	0.360	2.48	**CS**	**PA**
Gypsophila cerastoides D.Don	0.67	30.00	2.22	0.074	2.67	**SF**	**PA**
Hypericum elodeoides Choisy	0.50	16.67	3.00	0.180	1.99	**TF**	**PA**
Impatien sulcata Wall.	0.67	20.00	3.33	0.167	2.81	**TF**	**UP**
Iris kemaonensis Wall. ex D.Don	2.67	83.33	3.20	0.038	15.86	**TF**	**UP**
Lactuca dissecta D.Don.	1.20	36.67	3.27	0.089	3.57	**SF**	**PA**
Ligularia amplexicaulis DC.	0.40	16.67	2.40	0.144	1.49	**TF**	**UP**
Lychnis nutans Benth.	0.20	10.00	2.00	0.200	0.94	**SF**	**PA**
Malaxis muscifera (Lindl.) Kuntze	0.30	6.67	4.50	0.675	0.90	**SF**	**PA**
Meconopsis aculeata Royle.	0.60	26.67	2.25	0.084	2.22	**TF**	**UP**
Morina longifolia Wall. ex DC.	0.40	26.67	1.50	0.056	1.98	**TF**	**UP**
Nepeta laevigata (D.Don) Hand-Mazz.	0.27	13.33	2.00	0.150	1.26	**SF**	**PA**
Nepeta podostachys Benth.	0.17	20.00	0.83	0.042	1.24	**SF**	**PA**
Parnassia cabulica Planch. ex C. B. Clarke	0.40	30.00	1.33	0.044	2.13	**SF**	**PA**
Pedicularis hoffmeisteri Klotzsch	0.50	26.67	1.88	0.070	2.34	**SF**	**UP**
Pedicularis longiflora Rudolph	0.33	10.00	3.33	0.333	1.07	**SF**	**UP**
Pedicularis pyramidata Royle ex Benth.	0.17	6.67	2.50	0.375	0.71	**TF**	**UP**
Phlomis bracteosa Royle ex Benth.	0.73	26.67	2.75	0.103	3.29	**TF**	**PA**
Pilea scripta Buch.-Ham. ex D. Don) Wedd.	0.83	23.33	3.57	0.153	2.59	**TF**	**PA**
Plantago lanceolata L.	0.53	30.00	1.78	0.059	2.66	**SF**	**PA**
Pleurospermum brunonis Benth. ex C.B.Clarke	0.67	20.00	3.33	0.167	2.81	**SF**	**PA**
Polygonatum multiflorum (L.) All.	0.50	16.67	3.00	0.180	1.67	**TF**	**PA**
Polygonatum verticillatum (L.) All.	1.20	13.33	9.00	0.675	2.69	**TF**	**PA**
Polygonum capitatum Buch.-Ham. ex D. Don	1.27	30.00	4.22	0.141	4.49	**TF**	**PA**
Potentilla atrosanguinea G. Lodd. ex D.Don	1.87	20.00	9.33	0.467	4.38	**TF**	**PA**
Potentilla cuneata Wall. exLehm.	0.97	16.67	5.80	0.348	2.42	**TF**	**PA**
Primula denticulata Sm.	1.67	33.33	5.00	0.150	6.28	**SF**	**UP**
Primula glomerata Pax.	1.33	43.33	3.08	0.071	6.95	**SF**	**UP**
Ptercanthus urticifolius (Wall. ex Kuntze) Bremek	0.60	20.00	3.00	0.150	1.86	**TF**	**PA**
Ranunculus brotherusii Freyn.	0.83	16.67	5.00	0.300	2.30	**SF**	**PA**
Roscoea alpina Royle	1.00	20.00	5.00	0.250	2.31	**SF**	**PA**
Rubiacor difolia L.	0.93	16.67	5.60	0.336	2.62	**SF**	**PA**
Rumex acetosa L.	1.00	50.00	2.00	0.040	5.30	**TF**	**UP**
Rumex nepalensis Spreng.	1.10	40.00	2.75	0.069	5.92	**TF**	**UP**
Saussurea graminifolia Wall. ex DC.	0.83	30.00	2.78	0.093	5.37	**SF**	**PA**
Saxifraga parnassifolia D.Don	0.50	16.67	3.00	0.180	1.61	**SF**	**PA**
Saxifraga sibirica L.	0.33	13.33	2.50	0.188	1.26	**SF**	**PA**
Selinum tenuifolium Salisb.	0.67	20.00	3.33	0.167	2.55	**TF**	**UP**
Senecio graciliflorus (Wall.) DC.	0.73	30.00	2.44	0.081	3.59	**TF**	**UP**
Sibbaldia purpurea Royle	1.13	30.00	3.78	0.126	3.78	**SF**	**PA**
Silene edgeworthii Bocquet	0.67	33.33	2.00	0.060	2.64	**SF**	**PA**
Swertia purpurascens Boiss.	1.50	30.00	5.00	0.167	5.08	**TF**	**UP**
Tanacetum dolichophyllum (Kitam) Kitam.	0.50	16.67	3.00	0.180	1.82	**SF**	**UP**
Taraxcacum officinale F.H. Wigg.	0.67	30.00	2.22	0.074	2.67	**SF**	**UP**
Thelypteris sp. Schmidel	1.17	23.33	5.00	0.214	4.64	**TF**	**UP**
Thymus linearis Benth.	2.20	43.33	5.08	0.117	5.26	**SF**	**PA**
Urtica dioica L.	1.17	30.00	3.89	0.130	6.66	**TF**	**PA**
Verbascum thapsus L.	0.67	30.00	2.22	0.074	2.99	**TF**	**UP**

Note: TF= Tall Forbs (> 30cm), SF= Short Forbs (<30cm), CS= Cushion and Spreading Forbs
PA= Palatable Species, UP= Unpalatable Species

The value of dominance index (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.021, 4.170, 10.203 and 0.946 respectively. The lower value of dominance index and higher value of diversity index was observed by Santvan (1993) in the alpine vegetation near Rahla in Kullu, Himachal Pradesh. Similar finding were also reported by Verma *et al*. (2008); Verma and Kapoor (2012); Verma and Kapoor (2014) while studied alpine pastures of Himachal Pradesh. The value of concentration of dominance (C), index of diversity (H), richness index (R) and evenness index (E) for trees, shrubs and herbs at different altitudes. The higher the value of concentration of dominance, the greater is the homogenous nature of the community and vice- versa (Kohli *et al*., 2004). The lower value of dominance shows that dominance of plants is shared by many species. The species diversity is regulated by long term factors like community stability and evolutionary time as heterogeneity of both macro and micro environment affects the diversification among different communities. The higher values of index of diversity indicate the variability in the type of species and heterogeneity in the communities, whereas, the lesser values point to the homogeneity in the community. The higher value of evenness indices indicates that species are evenly distributed in this region. The nature of plant community at a place is determined by the species that grow and develop in such environment (Bliss, 1962).

Medicinal and Threatened Plants: The plants of medicinal values found in the different this alpine pasture were documented Chopra *et al.* (1956); Kirtikar and Basu (1987); Kala (2002). Total 48 medicinal plant species recorded from the studied alpine pasture. These were *Achillea millefolium, Aconitum heterophyllum, Aconogonum molle, Allium humile, Anaphalis contorta, Anemone obtusiloba, Anemone tetrasepala, Ainsliaea latifolia, Artemisia parviflora, Bergenia stracheyi, Bistorta amplexicaulis, Chaerophyllum reflexum, Corydalis govaniana, Cynodon dactylon, Cynoglossum micranthum, Erigeron multiradiatus, Fragaria nubicola, Geranium wallichianum, Gerbera gossypina, Geum elatum, Hypericum elodeoides, Iris kemaonensis, Lactuca dissecta, Lychnis nutans, Malaxis muscifera, Meconopsis aculeata, Nepeta podostachys, Phlomis bracteosa, Plantago lanceolata, Pleurospermum brunonis, Polygonatum multiflorum, Polygonatum verticillatum, Polygonum capitatum, Potentilla argyrophylla, Potentilla atrosanguinea, Primula denticulata, Roscoea alpine, Rubia cordifolia, Rumex acetosa, Rumex nepalensis, Selinum tenuifolium, Senecio graciliflorus, Tanacetum dolichophyllum, Taraxacum officinale, Thymus linearis, Trifolium pretense, Trifolium repens, Urtica dioica* and *Verbascum thapsus.*

Out of 48 medicinal plant species found in the studied alpine pasture, 8 species *viz*., *Aconitum heterophyllum, Bergenia stracheyi, Malaxis muscifera, Meconopsis aculeata, Polygonatum multiflorum, Polygonatum verticillatum, Roscoea alpina* and *Selinum tenuifolium* fall in the category of threatened plant specieswhen compared with the available literature like Red Data Book and CAMP Reports (Ved *et al.*, 2003).

The rarity in these medicinal plants is due to habitat alteration, narrow range of distribution along with other factors. A major threat is for the species those are uprooted and their underground parts such as rhizomes, tubers, bulbs and roots are used in medicine. The habitat of most of the plant species have shrunk due to expansion of human population and environmental degradation primarily due to heavy live-stock grazing, uncontrolled and unscientific harvest of species, unregulated tourism and construction of road etc. The better conservation of natural resources can be done by inclusion of a section on the plant conservation especially of rare and endangered medicinal plants in the wild life protection act, promotion of community based conservation, *ex-sittu* conservation through tissue culture, developing cultivation technologies and nurseries of medicinal plants and conduction of regular training on the procedure of medicinal plants collection, processing among the local people, traders and real stake holders.

In the present study besides leguminous forbs and few grasses, non-leguminous forbs *viz*., *Anaphalis contorta, Anemone obtusiloba, Anemone tetrasepala, Iris kemaonensis, Primula denticulata, Primula glomerata, Thymus linearis* etc, were mostly dominant in the pasture. It may be due to heavy grazing pressure. The dominant non leguminous forbs are not preferred by the animals for eating. The results are in conformity with the earlier studies made by Singh (1967), Santvan (1993); Verma *et al.* (2008). The overgrazing results in changes in botanical composition which however, varies with the type of vegetation cover, its palatability, forage productivity, the way it is utilized and sequence of climate events (Shankaranarayan, 1977; Kapoor and Singh, 1991) which necessitate suitable strategies for management by regulating the grazing. If suitable steps are not taken well in times, there could be further decline in the density of preferred species of leguminous and non leguminous forbs.

The ecological studies of all alpine pastures of Himalayan states should be carried out to know the present status of these pastures and thereby devising suitable strategies for their scientific management.

CONCLUSION

In Mural Danda alpine pasture besides leguminous forbs and few grasses, non leguminous forbs were mostly dominant. The dominant non leguminous forbs are not preferred by the animals for eating. The contribution of short forbs were more than tall and cushion & spreading forbs. There is a need to take some steps to stop further decline in the density of preferred plant species and suitable strategies should be develop for management of alpine pasture by regulating the grazing.

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REFERENCES

Arya, S. C. and Samant, S. S. (2017). Assessment of vegetation and prioritization of communities for conservation in Latakharak alpine meadows of Nanda Devi Biosphere Reserve, West Himalaya, India. *International Journal of Advance Research, 5*(9): 1349-1366.

Billings, W. D. (1978). High mountain ecosystems: evolution, structure operation and maintenance. 275: In High Altitude Geoecology AAAS selected Symposium 12. Webber, P.J. (eds.). Boulden, Colorodo.

Bliss, L. C. (1962). Net primary production in Tundra ecosystem. 35-46. In Sounder druckaus.die. Stoff. Production der. pflangen, decke. Lieth, H. (eds.). Gustav. Flasher Verlag, Stuttaort.

Bliss, L. C. (1971). Arctic and alpine plant life cycles. *AnnualReview of Ecology and Systematics, 2*: 405-438.

Chopra, R. N. Nayar, S. L. and Chopra, I. C. (1956). *Glossary of Indian Medicinal Plants.* CSIR, New Delhi. 170pp.

Curtis, J. T. and Cottam, G. (1956). *Plant Ecology Work Book: Laboratory Field Reference Manual*. Burgess Publishing Co., Minnesota. 193pp.

Curtis, J. T. and McIntosh, R. P. (1950). The interrelations of certain analytic and synthetic phytosociological characters. *Ecology*, *31*: 434-455.

Hill, M. O. (1973). Diversity and its evenness, a unifying notation and its consequences. *Ecology*, *54*: 427-432.

Kapoor, K. S. and Singh, R. (1991). An analysis of standing crop and variety ratio of temperate grasslands under biotic pressure in Shimla hills. *Trop. Forestry, 7*: (11

Kala, C. P. (2002). *Medicinal plants of Indian trans-Himalaya*. Bisen Singh Mehendra Pal Singh, New Connaught Place, Dehradun (India). 200p.

Kaur, R. Joshi, Venita and Joshi, S. P. (2010). Impact of degradation on biodiversity status and management of an alpine meadow within Govind Wildlife Sanctuary and National Park, Uttarkashi, India. *International Journal of Biodiversity Science, Ecosystem Services & Management, 6*(3-4); 146-156.

Kershaw, K. A. (1973). *Quantitative and Dynamic Plant Ecology*. Edward Arnold Ltd., London, 308p.

Kirtikar, K. R. and Basu, B. D. (1987). *Indian Medicinal Plants*.International Book Distributors, Rajpur Road, Dehradun, *14*, 2791 p.

Kohli, R. K. Dogra, K. S. Batish, D. R. and Singh, H. P. (2004). Impact of invasive plants on the structure and composition of natural vegetation of Northwestern Indian Himalayas. *Weed Technology, 18*: 1296-1300.

Kunhikannan, C. Verma, Ram K. Verma, Raj, K. Khatri, P. K. and Totey, N. G. (1998). Ground flora, soil microflora and fauna diversity under plantation ecosystem in bhata land of Bilaspur, Madhya Pradesh. *Environment and Ecology, 16*(3): 539-548.

Margalef, R. (1958). Temporal succession and spatial heterogeneity in phyto-plankton. 323-347: In Perspective in Marine Biology. Buzzati-Traverso, A. (ed.). University of California Press, Berkeley.

Nautiyal, S. and Kaechole, H. (2006). Advance impact of pasture abandonment in Himalayas of India: Testing efficiency of a natural resource management plan (NRMP). *Environ. Impact Assess. Rev*., *27*: 109-125.

Saville, D. B. (1972). Arctic adaptation in plant. *Can. Dep. Agric. Monogr.*, No. 6.

Santvan, V. K. (1993). Ecological studies on alpine vegetation near Rahla, Kullu, Himachal Pradesh. Ph. D. Thesis, Himachal Pradesh University, Summer Hill, Shimla (H.P.). 358pp.

Singh, L. Sharma, N. and Joshi, S. P. (2017). Fodder resources in temperate fruit valley of western Himalaya, India. *International Journal of Scientific and Research Publications*, *7*(12): 571-587.

Singh, J.S. and Yadava, P.S. (1974). Seasonal variation in composition, plant biomass and net primary productivity of a tropical grassland at Kurukshetra, India. *Ecology Monograph, 44*: 357-375.

Singh, J.S. (1967). Seasonal variation in composition, plant biomass and net community production in the grassland at Varanasi. Ph.D. Thesis. Banaras Hindu University, Varanasi, India. 318 pp.

Shannon, C. E. and Wiener, W. (1963). *The Mathematical Theory of Communication*. Univ. of Illinois Press. Urbana, U.S.A.

Simpson, E. H. (1949). Measurement of diversity. *Nature*, *163*: 688.

Shankranarayan, K. A. (1977). Impact of over-gazing on the grasslands. *Ann. Arid. Zone, 16:* 349-359.

Verma, R. K. Jishtu, V. Kapoor, K. S. and Kumar, S. (2008). Plant diversity in alpine pasture of Talra Wildlife sanctuary of district Shimla, Himachal Pradesh. *Indian Journal of Forestry, 31*(1): 13-18.

Verma, R. K. Subramani, S. P. Kapoor, K. S. and Kumar, Surinder, (2006). Plant diversity in alpine pastures of Shikari Devi Wildlife Sanctuary of district Mandi, Himachal Pradesh. *Environment & Ecology*, *24*(2): 243-248.

Ved, D. K. Kinhal, G. A. Ravikumar, K. Prabhakaran, V. Ghate, U. Sankar, R. V. and Indresha, J. H. (2003). *Conservation Assessment and Management Prioritisation for the Medicinal Plants of Jammu & Kashmir, H. P. and Uttaranchal*. Workshop held at HFRI, Shimla August 22-25, 2003. FRLHT, Bangalore, India.206 p.

Verma, R. K. and Kapoor, K. S. (2012). Plant diversity in alpine area of Kalatop-Khajjiar wild life sanctuary of District Chamba, Himachal Pradesh. *Environment & We An International Journal of Science and Technology*, *7*: 1-7.

Verma, R. K. and Kapoor, K. S. (2014). Status of plant diversity in alpine area of Rakchham-Chitkul Wild life Sanctuary of District Kinnaur, Himachal Pradesh. *Biological Forum – An International Journal, 6*(1): 5-12.

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