Comparative study of shrub diversity in lower Dachigam Kashmir Himalaya

Arif Yaqooob1*, Mohammad Yunus1 and G. A. Bhat2

1Department of Environmental Science, BBAU, Lucknow (U.P), India.
2Department of Environmental Sciences, University of Kashmir, Srinagar (Jand K), Kashmir, India.

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The present study was conducted in two different ecosystems, that is, Site I (village site) and Site II (protected site) in the lower part of Dachigam National Park (Jammu and Kashmir) in all seasons during 2010-2011. Site I is located towards the periphery of the National Park near habitations and is under heavy grazing pressures while Site II is located inside the National Park with mild interferences and is a controlled site. The values of diversity (H=2.228) as well as richness index (R= 0.867) were higher for Site II while dominance index showed higher value at Site I (C = 0.113). The evenness index showed more or less similar values for both sites (Site I = 0.497 and Site II = 0.499). The frequently occurring dominant shrub species during the study period based on importance value index (IVI) were Plectranthus rugosa, Rosa webbiana, Indigofera heterantha, Cotoneaster nummularia and Daphne oleoides at Site I and Indigofera heterantha, Clematis montana, Rosa macrophylla, Clematis grata and Rosa brunoni at Site II. The abundance to frequency ratio (A/F) indicated that most of the species present contagious pattern of distribution.

Key words: Shrub, biodiversity, species, grazing, Dachigam.

INTRODUCTION

High biodiversity is seen as an insurance against the decline in ecosystem services, and should therefore be preserved (Yachi and Loreau, 1999). But, the current decline in biodiversity largely through human activities has given rise to global biodiversity crisis which is a cause of concern at the prospect of a rapidly accelerating loss of species, population, domesticated varieties, erratic rainfall, drying up of water resources, land instability and increased rates of erosion. More than half of the habitable surface of the planet has already been significantly disturbed by the human activity (Hannah and Bowles, 1995) which change overall community structure (Shaforth et al., 2002) and in turn can ultimately affect community and population dynamics. Conservation biologists warn that 25% of all species could become extinct during the next 20 to 30 years and we are on the verge of mass extinction of the species (Wilson, 1985). The cause for the loss of species is numerous but the most important is the loss
of natural habitats. Biological diversity implies the variety of living organisms and includes diversity within species, between species and of ecosystems and the ecological processes of which they are a part (Gaston and Spicer, 2004). Spices diversity is considered to be one of the key parameters characterizing ecosystems and a key component of ecosystem functioning (Hutchinson, 1959). Globally, biodiversity is changing at an unprecedented rate as a complex response to several human-induced changes (Vitousek, 1994). Such changes are a cause of concern for ethical, economical, ecological and aesthetic reasons, but they also have a strong potential to alter ecosystem services such as the prevention of soil erosion and maintenance of hydrological cycles, and ecosystem goods, like tourism and recreation. In addition to these services, biodiversity influences many ecosystems properties such as productivity, decomposition rates, nutrient cycling resistance and resilience to perturbations (Loreau et al., 2001). Forests are the primary source to rejuvenate productivity of land through recycling of nutrients, which make physic chemical conditions of the soils favourable for plant growth (Bargali et al., 1998). The natural factors both biotic and abiotic, deforestation, burning of ground vegetation, fodder extraction, livestock grazing, etc, have caused a considerable depletion of wild population of flora and fauna of the forest areas responsible for exploitation of forests (Bargali et al., 1998) and other severe anthropogenic activities on the ecosystem will lead to removal of vegetation, soil erosion and could subsequently lead to soil and habitat degradation. Thus, the current decline in biodiversity largely through human activities is a serious threat to our ecosystem. The study of floristic features and various environmental factors e.g. physiographic, climate, soil, etc., the community stability and the factors correlation with the vegetation can be reached, which is crucial in terms of forest communities development and rehabilitation (Basiri, 2003). Grazing areas have become less and less productive resulting from over stocking of livestock. Conflicts over the use of land have increased due to increased demand for land by different sectors of the economy.

Kashmir Himalaya, due to its rich repository of vegetation has attracted naturalists and botanists for more than two centuries (Dar et al., 2001). The vegetation study of Dachigam has been carried out by Kachhroo and Singh (1976) which recognized different vegetation types based on habitat, form and density of dominant species. Although, the vegetation patterns are controlled by such factors as habitat, slope, exposure to sunlight and altitude, besides biotic factors, anthropogenic stresses followed by livestock browsing in shrub lands adversely affected the composition of vegetation, it is therefore important to conserve the vegetation of the study area. Therefore, the present study has been conducted to assess the seasonal variations in phyto-diversity and distribution pattern of shrubs in the studied sites.

METHODOLOGY

Study area

Dachigam National park is located between 34°5'-34° 10' N latitudes and 74°50'-75°10' E longitudes, covers an area of 141 km² and is about 22 km away from Srinagar City in Kashmir Valley. The area of Dachigam National Park was an exclusive hunting ground and protected area of the Maharaja of Jammu and Kashmir. But after independence, the area came under the control of forest department and in 1951, it was declared as a Wildlife Sanctuary. In 1981, the area was declared as National Park. The different forest types found in the area are: Temperate Moist Deodar forest, Temperate mixed deciduous forest, Cypress, Alder and blue Pine forest, Popular and Salix forest, Open Scrub forest, Sub open Birch and fir forests, Sub open Scrub and pastures and moist open Scrub. Besides, the area forms a very good habitat of wild birds including Himalayan Monal, Chakur, Patridge, Himalayan griffon, Vulture, Indian Sparrow, Hawk, Asiatic cuckoo, open scrub Swift, Indian pied kingfisher, Golden oriole, Blue magpie, Black Bulbul, Babbler, etc. and wild animals like Kashmir Stag, Leopard, Jackal, Hill fox, Himalayan Black Bear, Snow Leopard, Human langur, Musk deer, Leopard Cat, Himalayan Marmot, Flying Squirrel, Himalayan mouse, etc. The study was carried out at lower Dachigam on seasonal basis in two different ecosystems viz.; site- I (village site falls towards the periphery but inside the official boundary of the park) and site- II (protected site located within the heart of the park (Map 1).

Vegetation analysis

Numerous field surveys were conducted to study the community composition and other phytosociological characteristics at two selected sites during spring (March-May), summer (June-August), autumn (September-November) and winter (December-February) in 2010-2011. Phytosociological attributes of shrub species were studied by randomly laying 6 quadrats of 5 × 5 m size at each site (Sharma et al., 1983). Specimen of plant species encountered at each site during the study period was collected in flowering/fruiting stages and the specimens were identified at Centre of Plant Taxonomy Department of Botany, University of Kashmir. The plant material was processed using standard herbarium techniques (Rao and Jain, 1977). The vegetation data recorded quantitatively was analyzed for density, frequency and abundance following Curtis and McIntosh (1950). The relative values of these indices were determined using Phillips (1959). These values were summed up to get importance value index (IVI) of individual species (Curtis, 1959). The ratio of abundance to frequency (A/F) for different species was determined by eliciting the distribution pattern (Curtis and Cotton, 1956). Species diversity (H) was computed by using Shanon Wiener Information Index (Shanon-Wiener, 1963). Concentration of dominance was calculated according to Simpson (1949). The species richness or the variety component (R) was determined using Margalef (1958) while species evenness (E) and similarity index (S) both were determined using Pielou (1966) and Sorenson (1948), respectively.

RESULTS

A total of 13 shrub species were reported from site I (village site) and 22 shrub species from site II (protected site) (Tables 1 and 2). Same results were shown by Alhassan et al. (2006). Among all the species, Plectranthus rugosa showed highest values of density (35.23),...
Map 1. Map of Dachigam National Park, Kashmir India.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Species</th>
<th>D</th>
<th>RD</th>
<th>A</th>
<th>RA</th>
<th>F</th>
<th>RF</th>
<th>A/F</th>
<th>IVI</th>
<th>R.IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Berberis lycium</td>
<td>4.54</td>
<td>5.07</td>
<td>7.85</td>
<td>6.35</td>
<td>54.71</td>
<td>8.16</td>
<td>0.143</td>
<td>19.59</td>
<td>6.53</td>
</tr>
<tr>
<td>2</td>
<td>Cotoneaster nummilaria</td>
<td>7.68</td>
<td>8.57</td>
<td>7.89</td>
<td>6.38</td>
<td>97.85</td>
<td>14.61</td>
<td>0.08</td>
<td>29.56</td>
<td>9.86</td>
</tr>
<tr>
<td>3</td>
<td>Daphnae oleoides</td>
<td>6.67</td>
<td>7.44</td>
<td>9.03</td>
<td>7.31</td>
<td>72.62</td>
<td>10.84</td>
<td>0.124</td>
<td>25.59</td>
<td>8.53</td>
</tr>
<tr>
<td>4</td>
<td>D. mucronata</td>
<td>1.91</td>
<td>2.13</td>
<td>5.75</td>
<td>4.65</td>
<td>33</td>
<td>4.92</td>
<td>0.174</td>
<td>11.72</td>
<td>3.91</td>
</tr>
<tr>
<td>5</td>
<td>Indigofera heterantha</td>
<td>12.49</td>
<td>13.94</td>
<td>13.85</td>
<td>11.21</td>
<td>89.37</td>
<td>13.34</td>
<td>0.154</td>
<td>38.49</td>
<td>12.83</td>
</tr>
<tr>
<td>6</td>
<td>Lonicera quinquelocularis</td>
<td>1.16</td>
<td>1.29</td>
<td>2.33</td>
<td>1.88</td>
<td>50</td>
<td>7.46</td>
<td>0.0466</td>
<td>10.63</td>
<td>3.54</td>
</tr>
<tr>
<td>7</td>
<td>Parrotiopsis jacquemontiana</td>
<td>0.16</td>
<td>0.17</td>
<td>1</td>
<td>0.81</td>
<td>16</td>
<td>2.38</td>
<td>0.0625</td>
<td>3.36</td>
<td>1.12</td>
</tr>
<tr>
<td>8</td>
<td>Plectranthus rugosa</td>
<td>35.23</td>
<td>39.34</td>
<td>35.62</td>
<td>28.84</td>
<td>97.87</td>
<td>14.61</td>
<td>0.363</td>
<td>82.79</td>
<td>27.59</td>
</tr>
<tr>
<td>9</td>
<td>Rosa macrophylla</td>
<td>1.5</td>
<td>1.67</td>
<td>9</td>
<td>7.28</td>
<td>16</td>
<td>2.38</td>
<td>0.562</td>
<td>11.33</td>
<td>3.78</td>
</tr>
<tr>
<td>10</td>
<td>R. webbiana</td>
<td>15.8</td>
<td>17.64</td>
<td>18.21</td>
<td>14.74</td>
<td>87.25</td>
<td>13.02</td>
<td>0.208</td>
<td>45.4</td>
<td>15.13</td>
</tr>
<tr>
<td>11</td>
<td>Rhamnus purpureus</td>
<td>0.33</td>
<td>0.36</td>
<td>2</td>
<td>1.62</td>
<td>16</td>
<td>2.38</td>
<td>0.125</td>
<td>4.36</td>
<td>1.45</td>
</tr>
<tr>
<td>12</td>
<td>Spirea canscens</td>
<td>0.33</td>
<td>0.36</td>
<td>2</td>
<td>1.62</td>
<td>16</td>
<td>2.38</td>
<td>0.125</td>
<td>4.36</td>
<td>1.45</td>
</tr>
<tr>
<td>13</td>
<td>Ziziphus jujuba</td>
<td>1.74</td>
<td>1.94</td>
<td>8.95</td>
<td>7.24</td>
<td>23.28</td>
<td>3.47</td>
<td>0.384</td>
<td>12.65</td>
<td>4.21</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>89.54</td>
<td>100</td>
<td>123.48</td>
<td>100</td>
<td>669.95</td>
<td>100</td>
<td>2.5511</td>
<td>300</td>
<td>100</td>
</tr>
</tbody>
</table>

Where D=density; RD=relative density; F=frequency; RF=relative frequency; A=Abundance; RA=relative abundance; IVI=importance value index; RIVI=relative importance value index.

abundance (35.62) and frequency (97.87%) at site I while at site II, Indigofera heterantha showed highest density values (65.54) as well as frequency values (100%) and Clematis montana showed highest abundance values (19.91). Out of the total shrub species encountered at both sites during different seasons, 16 species were highly dominant based on importance value index (IVI). Dominant species based on IVI during all seasons at site I were P. rugosa (82.79), Rosa webbiana (45.40), I. heterantha (38.49), Cotoneaster nummilaria (29.56), Daphnae oleoides (25.59), Berberis lyceum (19.59), Zyzephus jajuba (12.65) whereas at site II dominant species recorded were I. heterantha (56.73), C.s montana (29.61), Rosa macrophylla (23.69), Clematis grata (22.39), Rosa brunoni (20.06), Jasminum officinale (14.63), B. lyceum (13.97) and Rubus niveus (12.09). Different diversity indices recorded at both sites are presented in Table 3. The perusal of the data revealed that diversity index (H),
evenness index and richness index maximum value were obtained at site II (H=2.228, E=0.499 and R=0.867) than site I (H=1.463, E=0.440 and R=0.490). However, dominance index revealed an inverse trend to that of Shannon diversity with lowest values reported at site II (C =0.078) and highest at site I (C=0.234). Same were the findings of Kharkwal et al. (2004). The abundance to frequency ratio (A/F) indicated that most of the species at site I performed contagious pattern of distribution except *Lonicera quinquelocularis* showing random distribution while as at site II *Sorbaria tomentosa* showed slightly random distribution and the rest of the species showed a contagious type of distribution. The results are in consonance with the findings of Shadangi and Nath (2005).

### DISCUSSION

Species diversity is considered to be one of the key parameters characterizing ecosystem and a major component of ecosystem functioning (Hutchenson, 1959). Species diversity, considered to be an outcome of the evolution of species in a biogeographic region is often a synthetic measure of the structure, complexity and stability of the ecosystem (Hubble and Foster, 1983). Species diversity is also important for the stability and proper functioning of ecosystems (Schlapfer et al., 1999), however, with increasing disturbance in the vegetation, the plant species diversity, richness and evenness are significantly reduced (Dar and Kaul, 1987). Diversity is a combination of two
factors: the number of species present, referred to as species richness and the distribution of individuals among species, referred to as species evenness or equitability. Species diversity therefore, refers to the variation that exists among the different life forms. In the present study, general structure of vegetation depicts that the species number was greater at site II (22) than at site I (13). The reason for maximum number of species at site I could be due to more availability of soil moisture and other environmental factors present in this area due to more vegetation cover (Alhassan et al., 2006). Comparatively, results of Shannon diversity at both sites fall within the range of studies carried out by Kiss et al. (2004). The species diversity was lower at site I (1.463) than site II (2.228) owing to adverse climatic conditions at this site (Shadangi and Nath, 2005) or lower rate of evolution and diversification of communities (Fischer, 1960). However, highest species diversity at site II might be due to the moderate level of grazing or anthropogenic disturbances and invasion of new species (Connell, 1978). Several studies mentioned similar results pertaining to the present study emphasizing moderate level of grazing promoted species diversity (Rikhari et al., 1993). However, others like Lubchenco (1978) considered it as a positive force that might increase species diversity in the community by preventing competitive exclusion by dominant species. The highest values of dominance index at site I (0.234) and lowest values (0.078) at site II having inverse relationship with diversity index (H) were also reported by Kharkwal et al. (2004). The lower value of dominance at controlled forest site showed that dominance of shrub layer is shared by many species. The Pielou’s indices at both sites were 0.440 (site I) and 0.499 (site II), indicating low dominance and more or regular distribution of shrub species at both sites. Lower richness values (0.490) at site I could be due to dry environmental conditions and also to slow growth rate, and maximum value (0.867) at site II could be due to favourable climatic conditions (Abdullah et al., 2009).

Species grow together in a particular environment because they have similar requirements for existence in terms of environmental factors such as light, temperature, water and soil nutrients and drainage etc. or they may also share the ability to tolerate the activities of animals and humans such as grazing, burning, cutting or trampling (Wood et al., 1994). It is generally argued that each individual species depends on some set of other species for its continued existence and the species have co-evolved in the ecosystem on which they depend (Paine, 1966). The loss of natural associations may be the probable reason for supporting low number of species (Walker, 1992). Ecological success, good power of regeneration and ecological amplitude of a species is governed by high IVI. Highest value of density and IVI by P. rugosa and R. webbiana indicate their dominance due to environmental suitability and ability of the species to survive grazing may be due to non-palatability or prickly nature, that is, adaption against herbivory or maximum utilization of available resource by that species (Kukshal et al., 2009). Difference in the species composition from site to site is mostly due to microenvironmental changes (Misra et al., 1997). Abundance and frequency ratio (A/F) ratio were in consonance with the study of Shadangi and Nath (2005), Greig-Smith (1957) etc., which reveals that most of the species were contagiously distributed whereas as regular distribution was reported almost negligible during present study. Dominance of contagious distribution may be due to the fact that the majority of species reproduce vegetatively in addition to their sexuality. Odum (1971) described that in natural conditions, contagious distribution is the most common type of distribution and is performed due to small but significant variation in environmental conditions while random distribution is found only in very uniform environment. The Sorensen’s similarity index shows that lower degree of similarity between sites I and II may be due to the different habitat conditions, non adjacent location or varied biotic interference at these sites.

Conclusion

The study concluded that with increasing disturbance in the forest vegetation, the plant species diversity, richness and evenness are significantly reduced and increase in shrub diversity and evenness at protected site may be due to less competition and availability of more space and nutrients or due to less or controlled biotic stresses. There is an urgent need to improve the vegetation cover at site I which could be achieved through regular monitoring of livestock grazing and biotic interference in addition to providing alternate grazing sites for livestock that will certainly tend to regenerate the vegetation of such threatened areas. However, increasing human activities like fuel fodder collection, harvesting of medicinal herbs, burning of ground vegetation inside the national park needs prime and immediate attention for sustainability. It is further recommended that species with low IVI need to be restored on priority basis by providing protection which ultimately help in regeneration process to maintain diversity in the selected sites.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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