Original article

Patterns of plant diversity in seven temperate forest types of Western Himalaya, India

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A B S T R A C T

Plant biodiversity patterns were analyzed in seven temperate forest types [*Populus deltoides* (PD), *Juglans regia*, *Cedrus deodara*, *Pinus wallichiana*, mixed coniferous, *Abies pindrow* (AP) and *Betula utilis* (BU)] of Kashmir Himalaya. A total of 177 plant species (158 genera, 66 families) were recorded. Most of the species are herbs (82.5%), while shrubs account for 9.6% and trees represent 7.9%. Species richness ranged from 24 (PD) to 96 (AP). Shannon, Simpson, and Fisher α indices varied: 0.17–1.06, 0.46–1.22, and 2.01–2.82 for trees; 0.36–0.94, 0.43–0.75, and 0.08–0.35 for shrubs; and 0.35–1.41, 0.27–0.95, and 5.61–39.98 for herbs, respectively. A total of five species were endemic. The total stems and basal area of trees were 35,794 stems (stand mean 330 stems/ha) and 481.1 m^2 (stand mean 40.2 m^2/ha), respectively. The mean density and basal area ranged from 103 stems/ha (BU) to 1,201 stems/ha (PD), and from 19.4 m^2/ha (BU) to 51.9 m^2/ha (AP), respectively. Tree density decreased with increase in diameter class. A positive relationship was obtained between elevation and species richness and between elevation and evenness ($R^2 = 0.37$ and 0.19, respectively). Tree and shrub communities were homogenous in nature across the seven forest types, while herbs showed heterogeneous distribution pattern.

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Introduction

The Himalayas are one of the youngest and richest ecosystems on earth with a variety of species and forest types due to the varying altitude, topographic, and climatic conditions (Mani 1978). The Himalayas cover about 12.84% of the total geographical area of India (Negi 2009). Himalayan forests are considered to be among the world's most depleted forests (Schickhoff 1995). Himalaya is recognized as one of the hotspots of biodiversity and harbors nearly 8,000 species of flowering plants, of which 25.3% are endemic (Singh and Hajra 1996). In the past 3 decades, there has been 23% loss of forest cover in western Himalayas (Anonymous 2005). Himalayas are complex and dynamic ecosystems that provide different ecosystem services (Khan et al 2012).

Species composition, community structure, and function are the most important ecological attributes of forest ecosystems, which show variations in response to environmental, as well as anthropogenic variables (Gairola et al 2008; Shaheen et al 2012; Bisht and Bhat 2013). A complex of factors viz. vegetation type, slope, aspect, edaphic factors, and altitude (Sharma et al 2009, 2010a; Gairola et al 2011a) determines the community composition, structure, and distribution pattern of diversity in mountain vegetation (Kessler 2001; Schmidt et al 2006). One important factor in mountain ecosystems is elevation (McVicar and Korner 2012), which has a strong influence on the structure of the vegetation in most mountains in the world (Zhang et al 2006). Changes in species diversity along elevational gradient have been the subject of numerous studies (Lomolino 2001; Fetene et al 2006), most of them found a *hump* shaped distribution, showing peak species diversity near the middle of the gradient (Austrheim 2002; Zhang and Ru 2010). The plant community structure and distribution pattern of Himalayan forests are poorly understood (Peer et al 2007). Western Himalaya not only supports huge floristic diversity (Sharma et al 2010b), but also stores large carbon stocks (Sharma et al 2010b; Dar and Sundarapandian 2015a, 2015b).

Kashmir Himalaya is located in the extreme northwest of the Himalayan biodiversity hotspot, and harbors a rich floristic diversity of immense scientific interest and supports about 12% of the country's total angiosperm flora and 3% of its endemics, while the
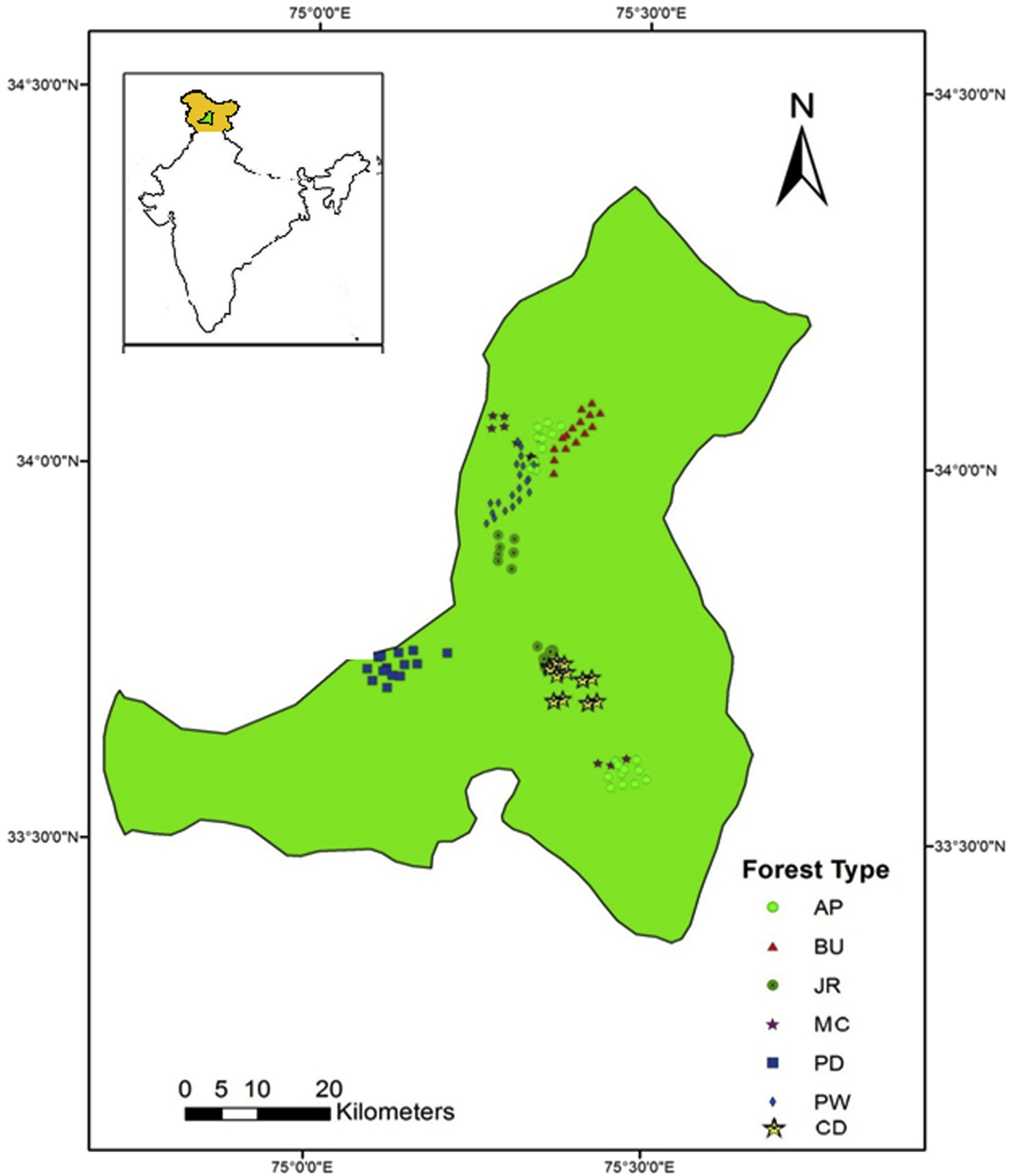
Figure 1. Location of the plots of seven temperate forest types of Kashmir Himalaya, India: AP = *Abies pindrow*; BU = *Betula utilis*; CD = *Cedrus deodara*; JR = *Juglans regia*; MC = mixed coniferous; PD = *Populus deltoides*; PW = *Pinus wallichiana*.

region represents only 0.4% of the total geographical area of India (Dar et al 2012). North-western Himalaya represents a unique bio-region owing primarily to its varied topography and habitat heterogeneity along a wide elevational range.

Several workers have also presented quantitative phytosociological work from different areas of Kashmir (Blatter 1928–1929; Dar and Kachroo 1982; Singh and Kachroo 1983; Ara et al 1995; Dar et al 1995, 2002; Khuroo et al 2004). However, there is a