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Original article

Tree diversity and community characteristics in Talle Wildlife Sanctuary, Arunachal Pradesh, Eastern Himalaya, India

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ABSTRACT

This study was carried out in a temperate forest for enumeration of floristic diversity and community characteristics analysis of the Talle Wildlife Sanctuary. A random sampling approach was adopted. Altogether, 63 species were recorded from the sampled area (0.2 ha). Family dominance results showed that Lauraceae was the most dominant followed by Fagaceae. Seventy percent of species showed low frequency distribution and species having higher frequency classes were almost absent or represented by only a few species. Dominance distribution of species resulted in a log normal distribution pattern which further signifies that the forest community was heterogeneous in nature. Species Prediction and Diversity Estimation analysis categorized 80% of the species as a rare species group and 20% as abundant species group. Estimation of coefficient of variation showed that rare species have equal detection possibilities in the sampled area. Distribution of basal cover in different girth classes indicates a reverse trend to that of stand density. The results of this study show that the forest community composition is highly clustered and loosely colonized in nature.

Introduction

Tropical forests, being a diverse plant community, have invited the attention of researchers over several decades in order to understand their complex structure, function, and ecology (Hubbell and Foster 1992; Givnish 1999; Tripathi and Tripathi 2010). However, such data on this level are not available on temperate forests to understand the forest ecology including plant diversity and community organization. Biotic factors such as density dependent effects on seed and seedling survivorship and recruitment are known to be important in maintaining tree diversity in tropical moist forests (Janzen 1970; Connell 1971) while such studies are lacking in temperate areas. Like other forests, temperate forests also experience varying levels of human activities like human population exploitation, fragmentation, fuelwood, agricultural expansion, nontimber forest products, grazing of livestock, and climate change. In fact, it is said that the temperate forests are generally subjected to more severe human impact than any other forest type (Reich and Bolstad 2001). How these rapidly changing factors impact species composition, structure, and function of tree communities is not well known and remains a critical gap in developing conservation plans. The climate of temperate forests is characterized by marked seasonality, and alternates between warm summers and markedly cool or cold winters (Reich and Bolstad 2001). Zobel et al (2011) reported that the development of the species pool of each community represents a long-term process, led by evolutionary and dispersal events. The tendency of species richness to increase with the area has proven remarkably consistent for a range of organismal groupings and in numerous geographical settings (Gould 1979; Wilcox 1980; Schoener 1988). Communities would contain only species that belong to their species pool, making their characteristic diversity equal to the observed total diversity (Helm et al 2015). It is of utmost importance to consider the habitat-specific species pool when studying the diversity or planning conservation of natural communities (Cam et al 2000; Partel 2014). Tree species diversity is an important aspect of forest ecosystem diversity (Rennolls and Laumonier 2000) and quantitative floristic sampling provides the necessary context for planning and interpreting long-term ecological research (Phillips et al 2003). Diversity of a community can be assessed using several nonparametric measures such as diversity indices and these measures have gradually gained credibility (Magurran 1988). Biodiversity maintenance is one of the major goals to attain forest

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sustainability (Osorio et al 2009). The dominant position of trees in forests and their impact on various ecological gradients, the identity, and composition of tree species can be expected to influence plant biodiversity (Barbier et al 2008). Although communities have depended on forest ecosystems for long, changing socioeconomic conditions, traditional approaches for the conservation of biodiversity have drawn little attention to the long-term sustainability of this human dependence on forest ecosystems. Keeping paucity on quantitative data on plant diversity, composition, community characteristics, and population structure is the reason the present study is undertaken to fill the gaps on data on temperate forests in particular and other forests in general.

Materials and methods

Study sites

The study was carried out in Talle Wildlife Sanctuary (TWS) which is distributed on an altitudinal zone of 1,700 m to 2,200 m above sea level in Ziro valley of Arunachal Himalaya, Northeast India. TWS is about 30 km from the Ziro valley, the headquarters of Lower Subansiri district of state. It covers an area of 337 km^2 and lies between 27° 34′ 4″N and 27° 35′ 14″N latitude and between 93° 58′ 58″E and 93° 59′ 49″E longitude. Having a varied altitudinal range, the climate in TWS is temperate with copious rainfall making it more of mesophytic type. During the winter the minimum temperature goes down beyond freezing point whereas the maximum temperature during the summer may be as high as 32°C. The high precipitation, fertile soil conditions, and lack of disturbance have given a scope to the growth of luxuriant vegetation. The forest of TWS was almost considered to be untouched, well managed, and protected by the Apatani tribe and complex in structure and function. A stratified sampling design was used to inventory the tree species of TWS.

Two permanent plots of 100 m × 100 m were demarcated in the TWS keeping physiographic conditions in account and each plot was subdivided into 20 m × 20 m quadrats for further study. Alternate quadrats were sampled in both the plots for plant enumeration assuming vegetation would be more or less similar in successive quadrats. Altogether, 30 such quadrats were sampled from the selected plots i.e. 15 quadrat/plot. Field surveys were carried out on a seasonal basis for the period of 2 years (from April 2013 to March 2015). All species were described in the field as well as the laboratory and given a field identification number that was used throughout the field study. Collected specimens of each species were identified with the help of floras and published literatures and confirmed with the Botanical Survey of India. Specimens of collected species were retained in the Plant Diversity Laboratory of the Forestry Department, *North Eastern Regional Institute of Science and Technology*. In addition, indicators of disturbance such as cutting, lopping, cattle grazing, nearness to human habitation, and collection of nonwoody forest products were also noted during the field study. Community characteristics such as frequency, density, abundance, species richness, dominance distribution, dispersion pattern, species diversity, and dominance index were calculated as per Magurran (1988). Importance value index for each species was also computed and it was expressed as the sum of relative density, relative dominance, and relative frequency of species in and among plots (Curtis 1959). Population structure of tree species (> 15 cm girth at breast *height*) was characterized as the size distribution using girth at breast *height* classes. All individual trees were grouped into eight girth classes i.e. 15–50 cm, 50–70 cm, 75–100 cm, 100–125 cm, 125–150 cm, 150–175 cm, 175–200 cm, and > 200 cm.

We have also estimated various biodiversity indices using Species Prediction And Diversity Estimation (SPADE) software such as species richness, Fisher's α index, Shannon's entropy, and Simpson's index as well as their effective numbers of species based on sample abundance or frequency data based on the species frequency data collected from the community to add as an adequacy for the result we have sampled (Chao and Shen 2010).

Results

Species richness and family dominance

Our approach was to study the tree species diversity of TWS. It is important to note that we were not sampling the total species diversity because of the large coverage of the sanctuary area. The study was based on the sampled area of 1.2 ha from permanent plots of 2 ha. We sampled 477 individuals/ha represented by 63 species (including 8 unidentified) from 28 families and 42 genera (Appendix 1) from the selected study area using species accumulation curves to understand that the sampled area was balanced. The species with maximum abundance includes *Michelia champaca* (21 individuals), *Castanopsis indica* (19 individuals), *Phoebe lanceolata* (18 individuals), *Quercus lamellose*, *Quercus dealbata*, and *Rhododendron arboreum* (14 individuals each). Of the 63 sampled species, large numbers of species were represented by only a few individuals. Lauraceae was among the most dominant families (8 species with 79 individuals) followed by Fagaceae (7 species with 77 individuals), Magnoliaceae (6 species with 56 individuals), Ericaceae (5 species with 43 individuals), and Rutaceae (4 species with 17 individuals). Twelve families were represented by only a single species and others by either two or three species.

SPADE analysis revealed that the species richness represented by all estimators/models was found to be same i.e. 63 except in the case of second order Jackknife which is 58. This process of statistical inference depends critically on the biological assumption that the community is "closed," with an unchanging total number of species and a steady species abundance distribution (Gotelli and Colwell 2010). In an open metacommunity, in which the assemblage changes size and composition throughout time, it may not be

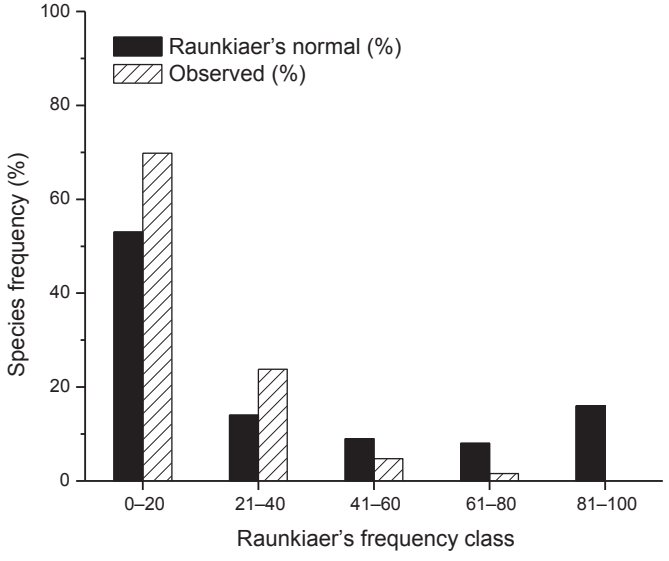

Figure 1. Frequency-distribution pattern of plant species in Talle Wildlife Sanctuary, Arunachal Himalaya.