

Effect of micro-environment and human disturbance on the diversity of herbaceous species in Sariska Tiger Project

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The tropical dry deciduous forest in Rajasthan have a dense layer of herbaceous vegetation during the rainy season which plays an important role in nutrient conservation and as a source of food for herbivores. Anthropogenic disturbances have adversely affected the composition of herbaceous vegetation; it is, therefore, imperative to conserve the herbaceous vegetation of these forests. Recently some efforts have been made to understand the plant community structure of the Sariska Tiger Project (Parmar 1985; Yadav & Gupta 2006). However, so far no attempt has been made to analyze the herbaceous vegetation of this forest. Hence the present investigation was undertaken to study the diversity of herbaceous species in relation to various micro-environmental conditions and human disturbance in the Sariska Tiger Project.

The Sariska Tiger Project, which covers an area of about 800 km², is situated in the north-eastern part of the Rajasthan. It falls in the category of thorn forest, according to the classification of forests given by Champion & Seth (1968). The terrain of this forest is hilly having valleys at 380 m elevation and the hills are as high as 640 m above sea level. The soil is sandy loam and alkaline with pH varying from 7.25 to 8.00 (Yadav & Gupta 2006). The climate of the Sariska Tiger Project is hot and semi-arid type.

Four study sites were established on the basis of the degree of human disturbance; (1) the Slopka

forest is an undisturbed area located in the core area, (2) the Kalighati forest was previously partially disturbed but now has been fully protected since 1979 and also situated in the core area, (3) the Bharthari forest is partially disturbed area located in the buffer zone, and (4) the Hajipur forest is highly disturbed area situated outside the periphery of the Sariska Tiger Project (Fig. 1). Observations of density, frequency and basal cover of the herbaceous layer were made by laying 10 quadrats (1 m²) each in the valley, at the base, middle and top of the hill slopes of different aspects in each of the four study sites from August 2003 to October 2003. The design of the experiment was as given in Yadav & Gupta (2006). The data collected were analysed for density and the importance value index (IVI) of different species following Misra (1968), Shannon-Weiner diversity index and Simpson index according to Odum (1971) and similarity index using the formula given by Sorenson (1948).

The number of herbaceous species recorded in the sample quadrats was 82 which is high as compared of the tropical dry deciduous forest (44) with similar hilly topography of the Navegaon National Park (Ilorkar & Khatri 2003). This high species richness may be attributed to the relatively open canopy of the tree layer. Peet (1978) suggested that dense tree canopies reduce herb richness by decreasing light. The number of species present in the valley of the Slopka forest

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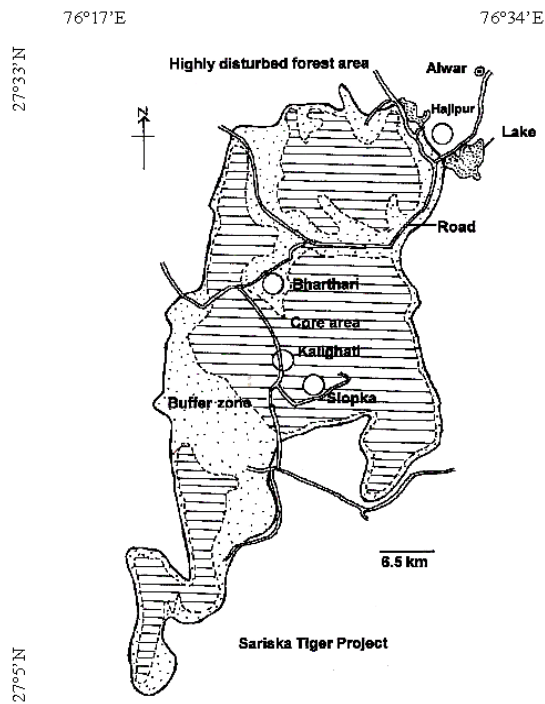


Fig. 1. Map of the Sariska Tiger Project showing the location of study sites (Source: Yadav & Gupta 2006).

was 30, being higher on east and west-facing slopes and lower on the north and south-facing slope. However, there was increase in cumulative number of species and shoot density of herbs with the increase in elevation of the hill slopes (Table 1). This may be attributed partly to the relatively open forest canopy and partly to high soil moisture content present at the higher elevation of slopes in rainy season. The aspect of hill slopes also affect the shoot density as it was highest at the top of the west facing hill slope whereas it was low on the north-facing hill slope. The relatively dry and hot conditions and open tree canopy of west facing slope favours growth of herbaceous species.

The dominant, on the basis of Importance Value Index (IVI), among 46 herbaceous species found on east-facing slope were *Adiantum incisum* (34) and *Commelina benghalensis* (46); out of 54 species on that of the west - facing slope were *Adiantum incisum* (39), *Aristida adscensionis* (20) and *Brachiaria ramosa* (21); on the north - facing slope among 48 species were *Aristida adscensionis* (33), *Commelina kurzii* (49); while out of 43 species on the south - facing slope was *Commelina*

benghalensis (49). These observations suggest that various aspects of hill slopes exhibit different floristic composition of herbaceous vegetation, possibly, depending upon the micro-environmental situations. Yadav & Gupta (2006) also suggested that the spatial heterogeneity created as a result of the presence of Aravalli hills increases diversity of woody species in the Sariska Tiger Project. The spatial heterogeneity may be caused by variation in soil moisture availability in arid land ecosystems (Evenari *et al.* 1971), surface structure of soil (Olsvig-Whittaker *et al.* 1983) and through the loss of soluble nutrients from the hills and their accumulation in the plains (Jayasuriya & Premdasa 1983).

Species diversity index (H') of herbaceous vegetation of the undisturbed Slopka forest was high (3.051) which may be attributed to the less completely closed canopy of this forest (Table 1). This is in conformity with Moral (1972) and Zobel *et al.* (1976) who observed high diversity in the herb layer in absence of a closed forest canopy. The micro-environmental situations also affected the species diversity. Valleys exhibited high species diversity, which decreased with elevation at hill slopes; was maximum on the north-facing slope and minimum on the south-facing slope. The Simpson index is inversely related to the species diversity index (H') in all micro-environmental situations (Table 1).

The human disturbance adversely affected the species richness of herbaceous vegetation which is as follows: Slopka forest (82) > Kalighati forest (76) > Bharthari forest (68). A large number of species such as *Abutilon ramosum*, *Acrachne racemosa*, *Blumea lacera*, *Melhania futteryporensis* and *Waltheria indica* were very sensitive to human disturbance and have disappeared from the disturbed areas. However, the number of species was very high (84) in the highly disturbed Hajipur forest which may be due to the large-scale invasion of weeds from surrounding agriculture fields and human settlements.

Species diversity index of the undisturbed Slopka forest was 3.051 followed by the Kalighati forest (3.415) and the Bharthari forest (3.027). However, in the Hajipur forest, species diversity index was high (3.564). This may be attributed to the increase in species richness due to invasion by weeds from surrounding agroecosystems. The 19 percent dissimilarity between the vegetation of the

Table 1. Soil and herbaceous vegetation features in different micro-environments in the undisturbed Slopka forest of the Sariska Tiger Project (\pm S.E.).

| Soil characteristics | Valley | Base of slope | Middle of slope | Top of slope |
|---|-----------------|-----------------|-----------------|-----------------|
| Thickness (cm) | <1m | 10.9 \pm 1.4 | 6.9 \pm 0.5 | 4.4 \pm 0.8 |
| pH | 8.1 \pm 0.01 | 7.9 \pm 0.05 | 7.7 \pm 0.02 | 7.4 \pm 0.01 |
| Organic carbon (%) | 1.31 \pm 0.01 | 1.43 \pm 0.01 | 1.11 \pm 0.02 | 0.92 \pm 0.02 |
| Cummulative species numbers | | | | |
| East facing slope | 30 | 40 | 46 | 54 |
| West facing slope | | 46 | 54 | 61 |
| North facing slope | | 41 | 51 | 55 |
| South facing slope | | 34 | 42 | 47 |
| Total shoot density (10^2 ha $^{-1}$) | | | | |
| East facing slope | | 2514 | 3370 | 4370 |
| West facing slope | | 2920 | 6540 | 10922 |
| North facing slope | | 2380 | 3249 | 3060 |
| South facing slope | | 1760 | 4150 | 6630 |
| Shannon-Wiener Index | | | | |
| East facing slope | 2.936 | 2.549 | 2.607 | 2.056 |
| West facing slope | | 2.900 | 2.441 | 2.174 |
| North facing slope | | 2.511 | 2.565 | 2.217 |
| South facing slope | | 2.693 | 2.299 | 1.69 |
| Simpson index | | | | |
| East facing slope | 0.07 | 0.129 | 0.115 | 0.289 |
| West facing slope | | 0.076 | 0.153 | 0.199 |
| North facing slope | | 0.114 | 0.106 | 0.217 |
| South facing slope | | 0.078 | 0.177 | 0.306 |

Table 2. Density of shoots $\times 10^2$ ha $^{-1}$ of important herbaceous species in the four study sites of the Sariska Tiger Project.

| Species | Slopka forest | Kalighati forest | Bharthari forest | Hajipur forest |
|---|---------------|------------------|------------------|----------------|
| <i>Achyranthes aspera</i> Linn. | 290 | 72 | 295 | 4 |
| <i>Adiantum incisum</i> Forssk. | 4718 | 205 | 475 | 397 |
| <i>Aristida adscensionis</i> L. | 1820 | 355 | 28 | 645 |
| <i>Blainvillea acmella</i> (L.) Phlipson | 133 | 37 | - | 69 |
| <i>Brachiaria ramosa</i> (L.) Stapf | 1020 | 437 | 4810 | 347 |
| <i>Commelina benghalensis</i> L. | 1723 | 635 | 2520 | 283 |
| <i>Heteropogon contortus</i> (L.) P. Beauv. ex. Roem & Schutt | 200 | 74 | 13 | 47 |
| <i>Indoneesiella echioides</i> (L.) Sreem | - | 57 | 40 | 52 |
| <i>Iseilema laxum</i> Hack | 565 | 47 | 285 | 31 |
| <i>Melhantha futteyporensis</i> Munro ex Mast. | 150 | 6 | - | - |
| <i>Setaria verticillata</i> (L.) P. Beauv. | 442 | 171 | 583 | 21 |
| <i>Triumfetta rhomboidea</i> Jacq. | 230 | 97 | 465 | 183 |

Slopka forest and the Kalighati forest suggests that the original species composition of the later forest community could not be restored even after providing complete protection for 25 years. Similar observation were made with respect to the woody vegetation in this forest (Yadav & Gupta 2006). The similarity index between the Slopka forest and the Bharthari forest was 0.70 and between the Slopka forest and the highly disturbed Hajipur forest was 0.68. It suggests that considerable changes occur in

the diversity of herbaceous species even due to partial disturbance to the vegetation. Thus, the large scale felling of trees and overgrazing may cause irreversible changes in the composition of the herbaceous vegetation of the fragile tropical dry deciduous forest ecosystems of Rajasthan. It may, therefore, be suggested that the rich species diversity of herbaceous vegetation of the Sariska Tiger Project may be protected only by *in situ* conservation.

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