

Chapter 10

DISCUSSION

DISCUSSION

Gorumara National Park (GNP) is a virgin broadleaf forest but the vegetation is very much disturbed. The Park belongs to the Bio-Geographical zone 7B (Lower Gangetic Plain) as recognised by Rodgers and Panwar (1988). Total area of this bottle shaped National Park is 79.99 sq km. The National Park is located in the flood plains of Jaldhaka and Murti rivers and other medium and small rivers and rivulets which have created a pocket of grassland there. The GNP has immense significance in view of it being situated in the middle of the elephant migratory route between the rivers Teesta and Torsa in North Bengal. Gorumara can become one part of the Managed elephant ranges for containing and sustaining the wild elephant population of North Bengal. Especially, the Tondu, Selka, Gorumara, Panjhora and Indong blocks serve as a major habitat for elephants and with more scientific management of these areas through the increase of fodder, cover and water resources, the elephant depredation problems can be substantially reduced. Main faunal resource of the GNP is Indian one horned Rhinos, Asian Elephant and Gaur. GNP has approximately 48 species of carnivores and herbivores, approximately 193 species of birds, 22 species of reptiles, 7 species of turtles, 27 species of fishes and other macro and micro fauna.

10.1 The Flora

After the comprehensive floristic survey, it is noted that the Gorumara National Park is housing an enormously rich flora. A total of 876 species of spermatophytes has been recorded from the intensive survey since the year 2006. Of these, angiosperms are represented by 872 species from 525 genera belonging to 159 families (Table 7.1). In addition, 4 species of 4 genera from 4 families of gymnosperms have been recorded from the GNP during the present exploration. The reason for sustenance of enormous richness in floral diversity within the forest is basically being the natural habitation areas and suitable climate of Terai and Duars foothills. The area receives annual precipitation of 200 – 400 cm, the major amount of which is received mainly during the monsoon months. However, little amount of rain is received almost in all other months. This type of distribution of precipitation maintains good relative humidity almost round the area that heled the formation of very good broadleaf floristic wealth in GNP and in nearby vegetation. The analysis of the flora revealed that there are numerous tropical, subtropical and even temperate elements those are common with the East Himalayan region. The beels, nallahas, other low-laying areas, scrubs, forests etc. provided enormous variety of habitats and that is reflected in the richness of the flora. The detailed analysis of the total spermatophytic flora of the forest shows that dicots have much dominance over the monocots and naturally occurring gymnosperms is represented by *Gnetum montanum* only. The recorded other three gymnosperms are introduced and are restricted in the gardens only. The GNP is falling within the natural distribution area of *Cycas pectinata* but during the present exploration its natural occurrence within the park was not detected.

The recorded largest genus in the GNP flora is *Ficus* of Moraceae, represented with 10 species and is followed by *Cyperus* of Cyperaceae, *Litsea* of Lauraceae, *Dioscorea* of Dioscoreaceae, *Cissus* of Vitaceae, *Desmodium* of Fabaceae etc. The best represented 10 genera in the GNP flora has been presented in Table 10.1.

Table: 10.1. Top 10 representative genera of GNP

Genus	Species
<i>Cyperus</i>	9
<i>Ficus</i>	8
<i>Litsea</i>	8
<i>Solanum</i>	7
<i>Eleocharis</i>	6
<i>Persicaria</i>	6
<i>Phyllanthus</i>	6
<i>Dioscorea</i>	5
<i>Commelina</i>	5
<i>Piper</i>	5

At the family level, the highest number of 53 species was recorded for the Fabaceae and it is followed by Asteraceae (33), Acanthaceae (19), Malvaceae (17) etc of Magnoliopsida. Recorded highest number of 34 species for Poaceae and is followed by Cyperaceae (24), Araceae (14), Commelinaceae (12) and then Orchidaceae (11) of Liliopsida (Fig. 10.1).

The present work in GNP, the appeared as the largest Fabaceae with 22 genera and 53 species and it is followed by Poaceae, Asteraceae, Rubiaceae, Cyperaceae, Lamiaceae, Acanthaceae, Moraceae, Malvaceae, Euphorbiaceae and Urticaceae and is presented in (Fig. 10.2).

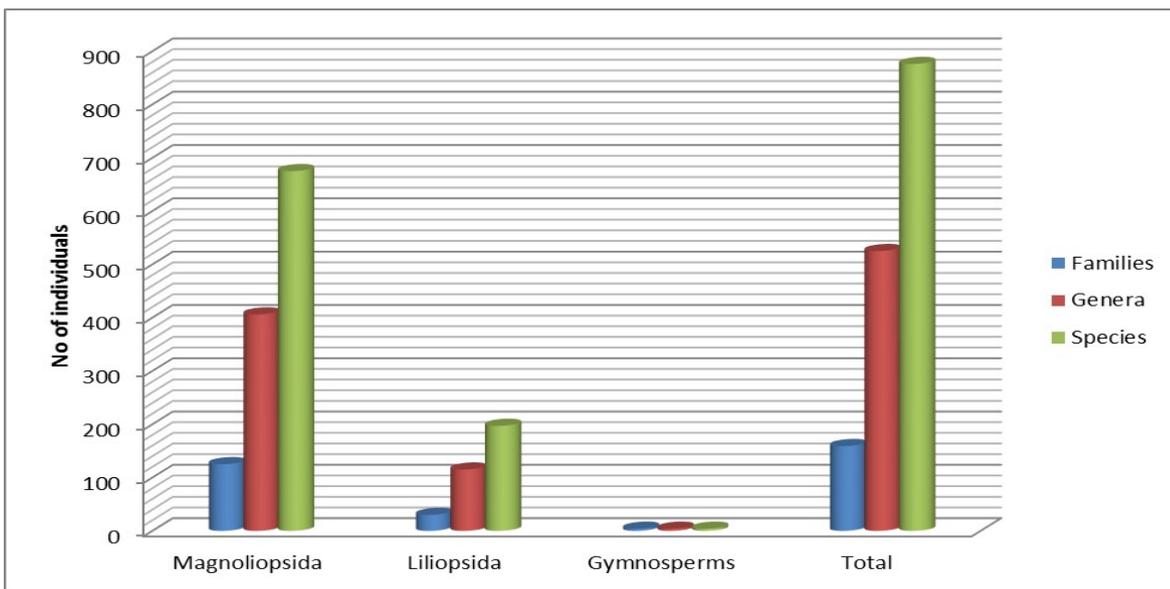


Fig. 10.1. Graphical presentation of relative distribution of the different major taxa of GNP

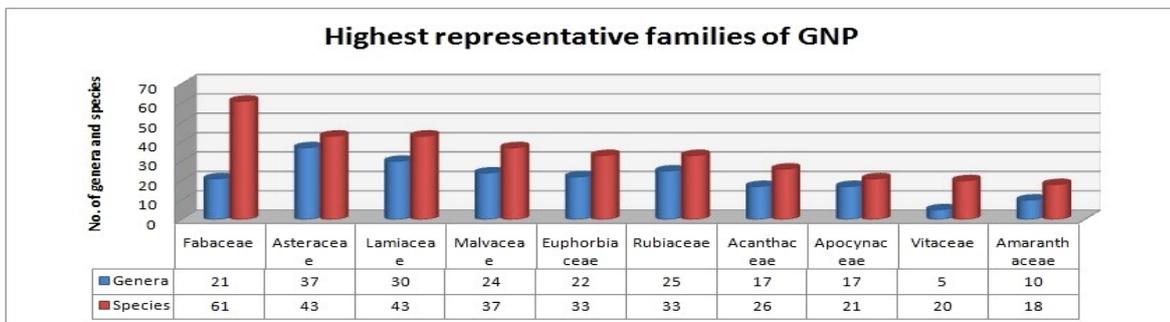


Fig. 10.2. Graphical presentation of relative distribution of genera and species of top ten families of GNP

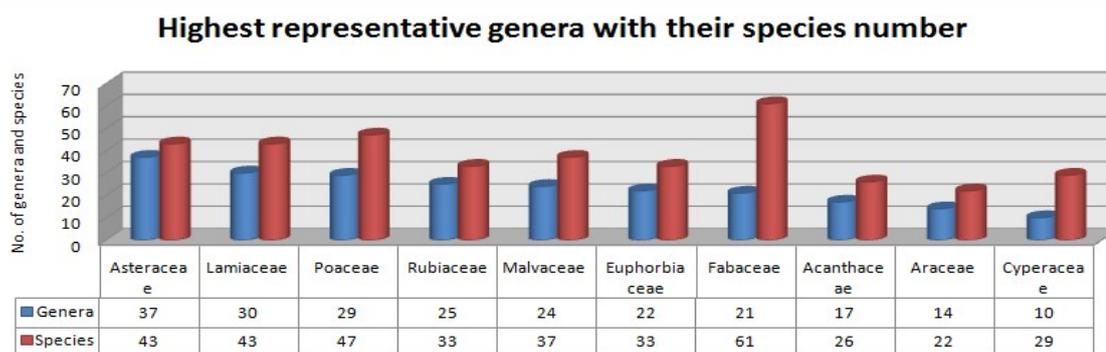


Fig. 10.3: The highest represented ten genera in GNP flora

10.1.1 Rare and threatened plants

The Gorumara National Park is one of the important conservatories for rare and threatened species of plants in the area. During the study, some of the threatened species of India, under *Red Data Books of Indian Plants* (Nayar and Shastri 1987, 1988, 1990) has also been recorded. These plants seem to be widely distributed inside the conservatory. The rarity of or threat to a majority of those could be due to several natural causes, but it could also be due to severe anthropogenic factors like habitat destruction through timber extraction, grazing, fishing, tourism etc. Unskilled and unscientific harvest of large number of species by local plant-traders for several identical purposes are attributing directly or indirectly in the population structure or even the loss of species from their natural habitat.

The knowledge of plants being used in medicine is high in the Indian Himalayan region and also in the Terai and Duars regions. There are major gaps in the knowledge of biological resources and the means by which biological diversity is being maintained (Heywood and Baste 1995; Biswas 2015). *Dioscorea deltoidea* is an endangered species found in this area. Two species, *Shorea robusta* and *Toona ciliata* has been recognized as 'Lower Risk/ Least Concern' under ver 2.3 in the Red List of IUCN [<http://www.iucnredlist.org/>], Indian Red Data Book [Nayar and Sastry, 1987, 1988] and Red List of Botanical Survey of India [http://bsi.gov.in/content/259_1_InventorisationofEndangeredPlantSpecies.aspx]. The only naturally occurring gymnosperm, *Gnetum montanum* is also a threatened species (Das & Yadav 2011). Insectivorous plants like different species of *Utricularia* and *Drosera burmanii* are also threatened plants but are with good representation in the GNP vegetation.

The entire Terai-Duars region provide more or less similar type of terrestrial vegetation, principally dominated by *Shorea robusta*. This region is a transit area, on its northern side there is Himalayan vegetation and vegetation of the Gangetic plains on the south. Many species migrated from these two sides are also taking shelter in this area.

10.1.2 Exotic Elements

In the Himalayas and its foothill region is rich with a total of 190 invasive alien species under 112 genera, belonging to 47 families (Chandra Sekar, 2012). Out of 190 invasive alien species, dicotyledons flora is represented by 40 families, 95 genera and 170 species and monocotyledons by 7 families, 17 genera and 20 species. Scattered research work on the exotic and alien species of India has been carried out by Maheswari 1962; Matthew, 1969; Maiti and Guha Bakshi, 1984; Das 1984; Das and Chanda, 1986; Das *et al* 1984; Khuroo *et al.* 2007a, 2008, 2010, 2012; Negi and Hajra 2007; Singh *et al.* 2010. Nayar (1977) has discussed the changing pattern of vegetation due to some exotic and invasive species. Liu *et al* (2005, 2006, 2008) has worked in detail on the exotic plants in China that has also included the Himalayan region. A preliminary list of exotic and introduced plants of India has been compiled by Pandey (2000) and Reddy (2008). Out of the 876 species of recorded flora, 98 species has been recognized as exotics. Out of these 63 has been naturalized (Tables 7.11 & 10.2).

Table 10.2: Taxonomic distribution and status of exotic plants in the flora of GNP

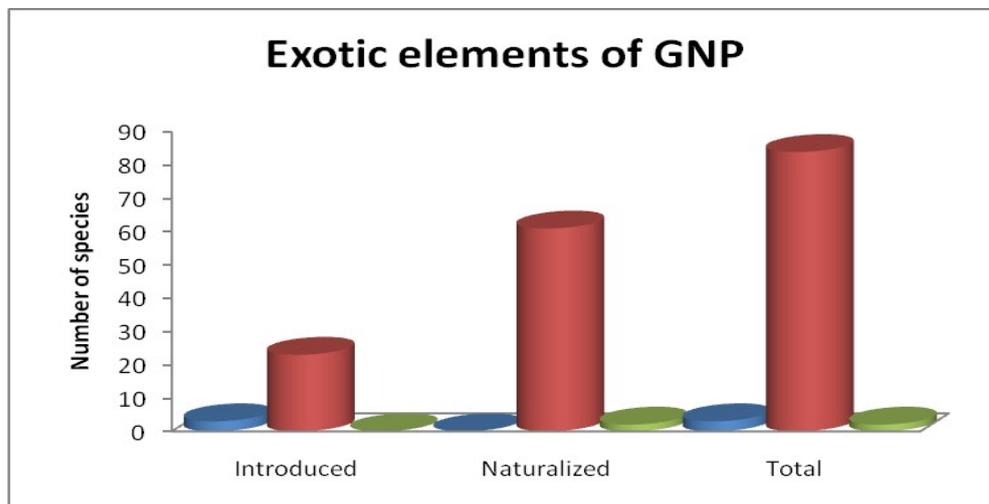
Taxa	Number of Exotic species		
	Introduced	Naturalized	Total
Gymnosperms	3	0	3
Dicotyledons	23	61	84
Monocotyledons	4	7	11
TOTAL:	30	68	98

Out of 98 exotic species, 25 species came from Tropical America, 15 from South America, 12 from Brazil and Mexico and only 6 species are of Asian origin. List of recorded exotic species is given in Table 7.12.

Among the monocots there are much less number of exotics but majority of them has been naturalized. Plants like *Eichhornia crassipes*, *Axonopus compressus*, *Pennisetum pauperum*, *Xyris pauciflora*, etc. are quite common inside the park area.

Mainly cultivated species are planted in gardens near the offices and villagers grow many such plants in their compounds either for their utilitarian characters or for ornamentation. Some exotic species were also found in the core area forests and these are all naturalized. Out of 4 Gymnosperm species 3 species has been detected as exotic elements. As much as seven monocotyledons species found there as naturalized exotic elements (Fig. 10.4).

Housing so many exotic species within a National Park is certainly disadvantageous. Many such species, e.g. *Lantana camara*, *Eupatorium odoratum*, *Ageratum conyzoides*, *Axonopus compressus*, etc. are occupying large areas of the park leading to the restricted distribution of many weaker local species. In wetland areas of the park invasion of *Eichhornia crassipes* is highly devastating as it is covering the water surface quickly and is not allowing the penetration of sunlight for the plants living below. So, proper strategies need to be formulated to keep these exotics under control.

**Fig. 10.4.** Graphical presentation of Exotic elements in the flora of GNP

10.1.3 Flowering calendar

Flowering calendar of the temperate flora of Darjeeling Hills (1500 – 2400 m) was previously prepared by Das and Chanda (1987) and for the Sambalpur District flora by Panda *et al.* (1992). The flowering seasons of species in Terai and Duars flora is little known till date. The flowering seasons of majority of the floristic elements of Rasik Beel complex has been recorded by Biswas (2015) and the present study recorded a clear flowering and fruiting season picture of GNP flora during the survey work and has been presented in the Fig. 10.5.

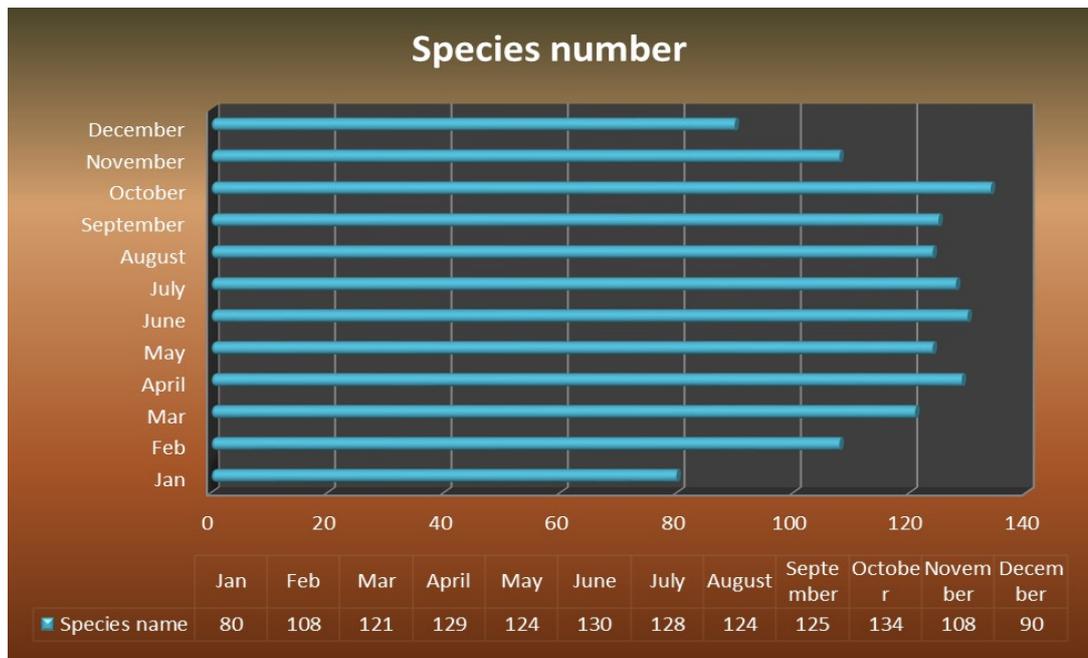


Fig. 10.5. Species showing maximum duration of flowering

Acmella uliginosa, *Ageratum conyzoides*, *Emilia sonchifolia*, *Lantana camara*, *Solanum americanum*, *Tabernaemontana divericata* etc are blooming for the round the year (Table 7.16) then followed by *Acmella paniculata*, *Achyrospermum wallichianum*, *Acmella calva*, *Bidens pilosa*, *Ficus hispida*, *Gnaphalium purpureum*, *Pseudognaphalium luteoalbum*, *Solanum torvum* etc blooming for 10 to 11 months, sometimes may be round the year (Fig. 7.4).

April, May, June and July and later September to October may be called as nature’s flower festival for GNP flora, because maximum number of angiospermic species found to bloom during these two periods every year. December to January appears to be the resting months, as very less number species go for flowering and most of these are winter annuals (Fig. 10.6). the length of the flowering for some species is also related to the soil-water relation. Quick drying of soil forcely end the flowering, whereas the same species continue to flower in some other sectors where the available soil-water is good enough for the purpose.

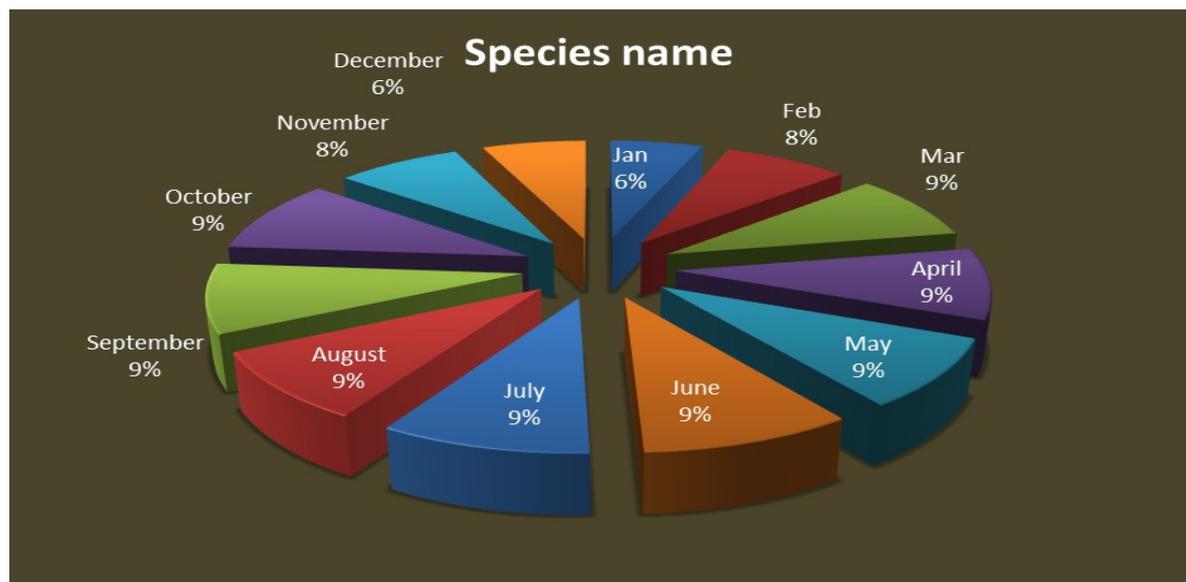


Fig. 10.6. Yearly flowering distribution of GNP flora

10.1.4 Effects of Anthropogenic activities

Some Forest Beats like Murti, Bichha Bhangra, Bhudhram are very much disturbed by the local villagers and poachers. The villagers are collecting many plants and plant-parts of commercial importance and daily-used materials from the forests. If this practice is continued for few more years, then most of the locally valuable, medicinal and economically important plant species of the forests will be vanished from the National Park. They are damaging vegetation when collecting fuel wood and fodder for their cattle and other domestic animals and are up-rooting most of the medicinal plants, irrespective of their age and maturity level without thinking the future of those plants in the habitat. The population of Aquatic rotifers, Molluscs, Zoo planktons and phytoplanktons are also being seriously affected by them due to fishery related activities in the water bodies like Indong, Gorati, Medlajhora, Dhupjhora etc. located in the core area. At the same time, the basic stock of food for the aquatic-birds, both native and migratory birds, are being affected due to all these activities. Poor knowledge of NTFP collection by local villagers is also adversely affecting the diversity and developing food crisis for aquatic and other birds. Too much trace on ecotourism is also seriously disturbing the local floral and faunal communities and also the overall environment of the area.

10.1.5 *Ex-situ* conservation

There is no facility for the *ex-situ* conservation of plants in the study area except for some species of Bamboos and *Phyllanthus emblica* planted to increase the supply of Elephants fodders and fruits for Birds. Forest department may try to stop these practices by planting naturally growing species like *Terminalia spp*, *Mangifera spp*, *Artocarpus sp*. etc. In the Murti River Beds, plantation forest area is also increasing and the species under use for the purpose are mainly *Phyllanthus emblica*, *Salix tetrasperma*, *Lagerstroemia speciosa*, *Lagerstroemia hypoluca*, *Terminalia arjuna*, *Terminalia bellirica*, *Syzygium cumini*, *Putranjiva roxburghii*, *Cassia javanica ssp. nodosa*, *Delonix regia*, *Lagerstroemia indica*, *Litchi chinensis*, *Spathodea campanulata* etc. It appears that for a conservatory devoted mainly for the bird conservation enough thought need to be given for the selection of species for plantation as those should be suitable for supply of food round-the-year and to provide suitable habitat for their nesting activities. If such conditions are developed then larger number of bird species, local as well as migratory, along with many other plants and animals will enrich such artificially created habitat. In addition, such activities will increase the forest area, stabilize the loose soil and will improve the water-relation for the vegetation.

10.2 Phytosociology of GNP

10.2.1 Ground-Cover Vegetation of GNP

Premonsoon habitat is characterized by the prevailing dry habitat conditions and is a continuation of the postmonsoon environment. But, due to better soil-water relation the soil, even in terrestrial sectors, can support some vegetation in both of these two seasons. So, the forest floor will never look barren and many ground cover species will continue to grow. Details of the premonsoon vegetation has been provided in Chapter 8 (Phytosociology) where it was shown that large number of species are surviving there with appreciable population structure. And, it is also interesting to note that species with high RD, RF, RA and IVI are different in different Forest Beat areas. Similarly, a good number of species has scored the maximum SDI value 1.

Figure 10.7 indicates that Diversity indices do not change abruptly in different seasons except the monsoon when large number of short-lived ephemerals grow, complete their life cycle and die. During premonsoon season there are occasional showers of rain and the ambient temperature remain high. So many geophytes start sprouting and many therophytes start producing seedlings during this season leading to the increase in species diversity and that form the climax during monsoon.

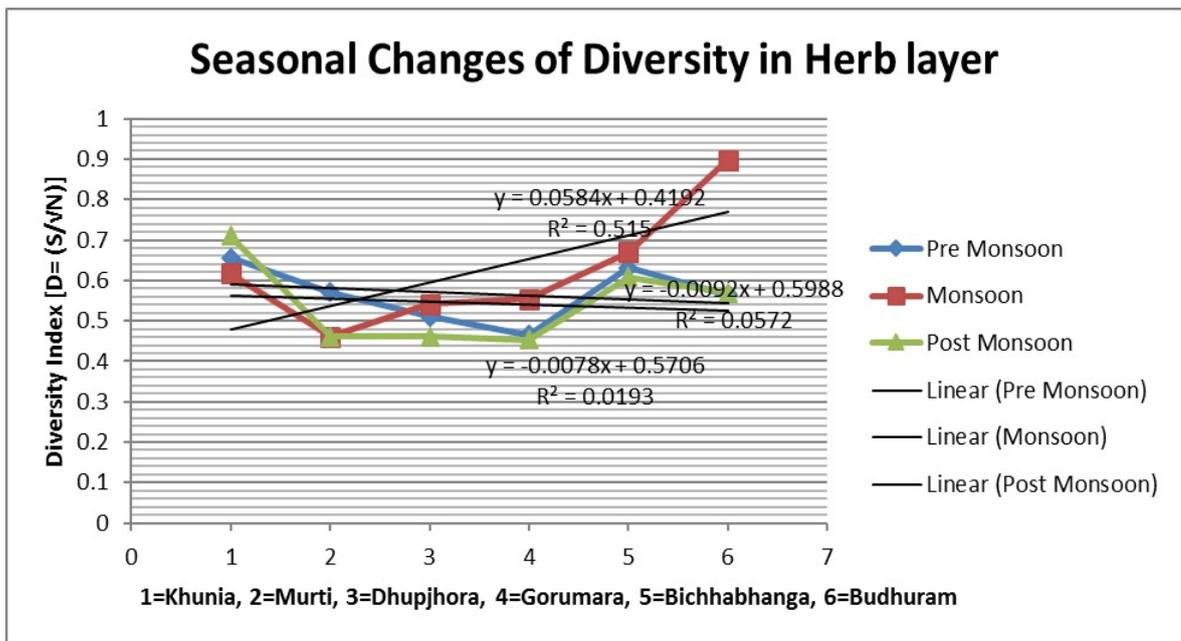


Fig. 10.7. Seasonal changes of Diversity Indices in the herb layer in vegetation in different Forest Beat

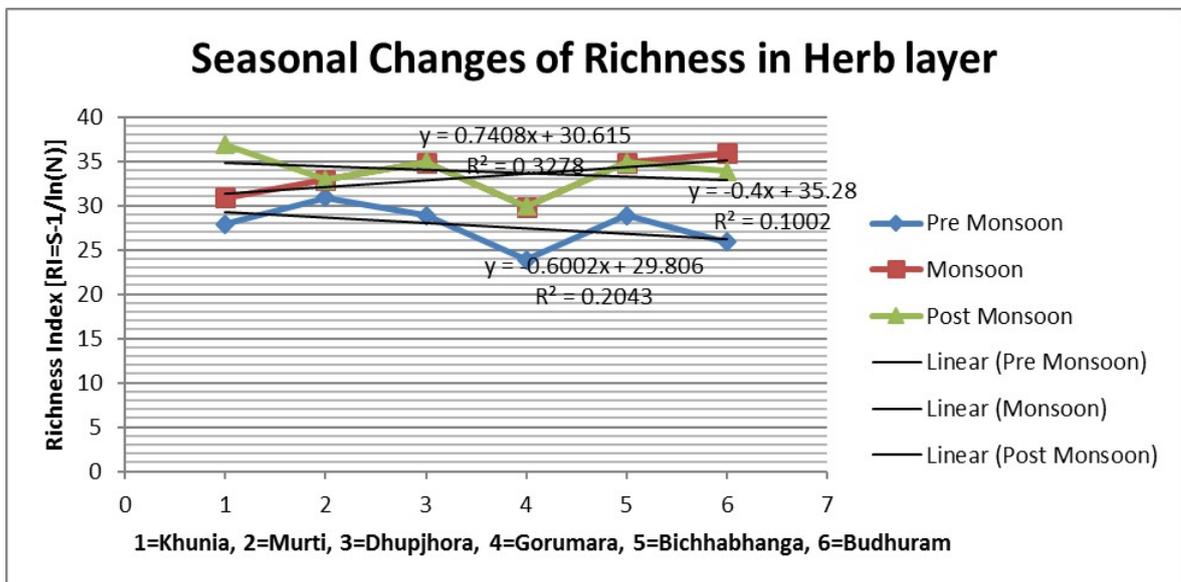


Fig. 10.8. Seasonal changes of Richness Indices in the herb layer in vegetation in different Forest Beat

Richness of a vegetation is expressed in Menhinick Richness Index (D). Fig. 10.8 shows the Richness Index in different seasons in different Forest Beat areas. And, the richness remain high in different seasons including post monsoon. Postmonsoon is also one important season for many species specially those adopted to grow in low ambient temperature. These small annuals can collect sufficient water from the environment as the dense fog in winter contribute some water to the habitat. Rivers flowing through the GNP are all originating in the Himalayas and carry huge amount of seeds of Himalayan plants. These seeds find the winter in GNP hospitable for them and they form a different type of association and thereby increase both Diversity and the Richness of the vegetation.

10.2.2. Shrub Layer Vegetation of GNP

Occurrence of shrub-species is comparatively less inside the deep forests with close canopy. But, the areas with open forests and in disturbed areas good number of shrub species form their own vegetation

type. Shrubs generally accompany some perennial soft-wooded shrubby-climbers. Like ground cover vegetation, in shrub layer too different species dominate in different sectors of the Park, i.e. in different Forest Beat areas. However, some aggressive naturalized exotics like *Chromolaena odorata* and *Lantana camara* are over-powering the local shrubs. Again, some shrubby-climbers like *Ichnocarpus frutescens*, *Argyreia roxburghii*, *Mikania micrantha*, *Natsiatum herpeticum*, *Celastrus paniculatus*, etc. are dominating over the erect shrubs as they can quickly climb over the shrubs and form dense network of their branches. However, even under such stressed condition, there is high diversity in the shrub layer which was expressed through the recognition of different species with high RF, RD, RA, and IVI. Shrubs are perennial plants but some of them are with suffrutescent habit. These plants reject their aerial branches in dry period and survive through their perennial root-stock. Interestingly, in GNP environment these plants never show perfect nature of suffrutescence. At least few lower branches remain green and leafy mainly due to the good soil-water relation of the habitat. Here the growth is hampered more by the low ambient temperature rather than water scarcity.

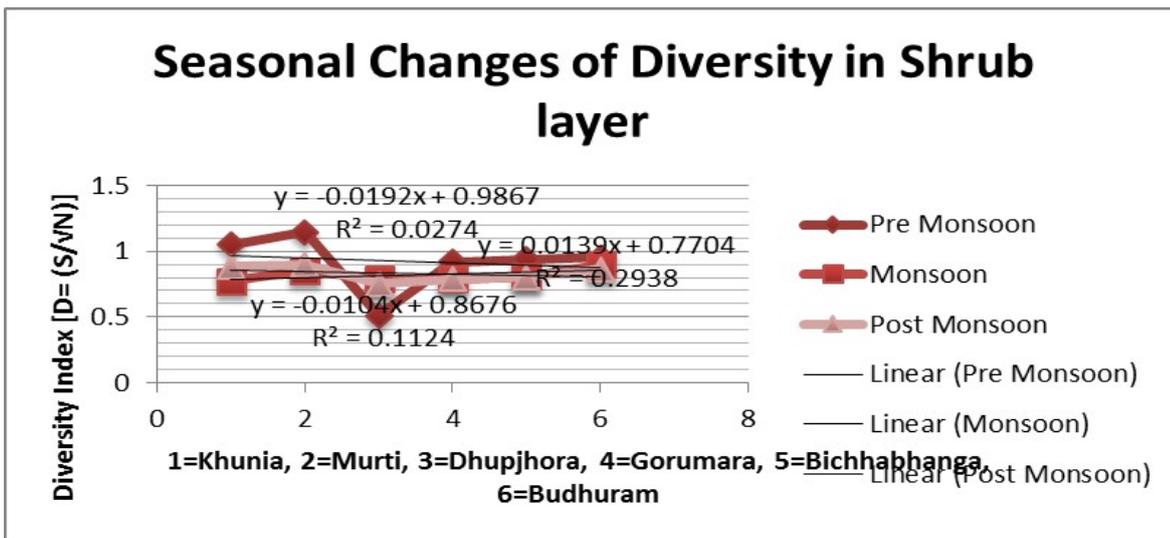


Fig. 10.9. Seasonal changes of Diversity in the shrub-layer vegetation in GNP

Figure 10.9 indicates that Diversity indices do not change abruptly in different seasons. This is certainly due to the perennial nature of the aerial parts of these plants. Pre- and post-monsoon shrub layer remain almost constant. But, in monsoon at Dhupjhora the diversity decreased suddenly. This is due to the excessive growth of few species those covers and dominate over many other shrubs. These are mostly the shrubby-climbers and these plants grows profusely on most of the bushes. Sometimes, they climb over the trees also. But, in most of the areas post monsoon vegetation looks better than pre-monsoon vegetation. This is due to the partial disappearance of some suffrutescent elements. However, the linear graphs show very little deviation in diversity in different seasons. Tree saplings and coppice growth sometime lead to the recognition of some tree-species as dominants for the shrub layer. These are found in most of the damaged forests due to human interferences.

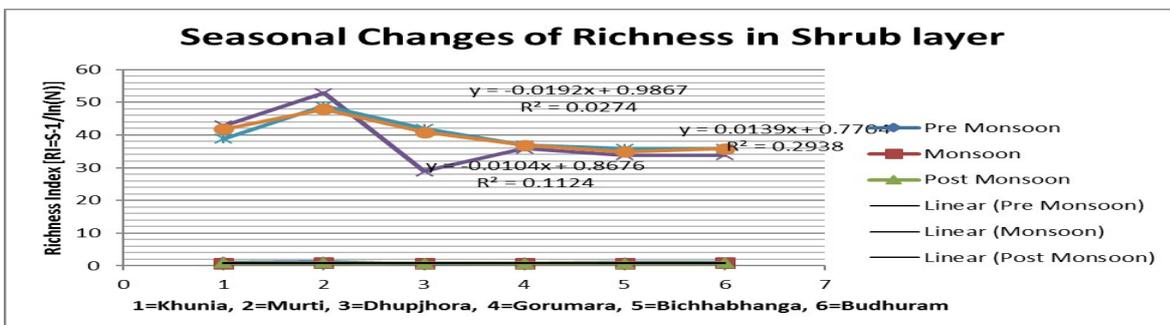


Fig. 10.10. Seasonal changes of Richness in the shrub-layer vegetation in GNP

Shrubs are perennial floristic elements. So, within one year, in different seasons, change in their population structure will not show any considerable or important change. Under such static situation the changes in Richness will not be visible. This has been presented in Fig. 10.10. However, there are prominent differences in Richness in different sectors of GNP. Scrutinee of Figs. 10.9 and 10.10 indicates the similar such differences and Dhupjhora Beat being the poorest while the Murti Beat with shows the highest diversity and richness status.

10.2.3. Canopy Layer of GNP

As it appeared from the present survey that the distribution pattern of different species of trees is not similar in different sectors of the Park. A good number of species were recorded with absolute frequency in different Forest Beat areas. However, there are some signs of man made changes. Probably before bringing the area under conservation good timbers were harvested which led to the reduction of the population of some species including *Shorea robusta*. The determination of species like *Actinidaphne obovata*, *Alangium chinensis*, *Alstonia scholaris*, *Albizia chinensis*, *Casaeria vareca*, etc. with absolute frequency is probably the indication of former forest extraction. However, even under this situation, *Shorea robusta* scored the highest value of IVI with its highest abundance recorded from Budhuram Beat area.

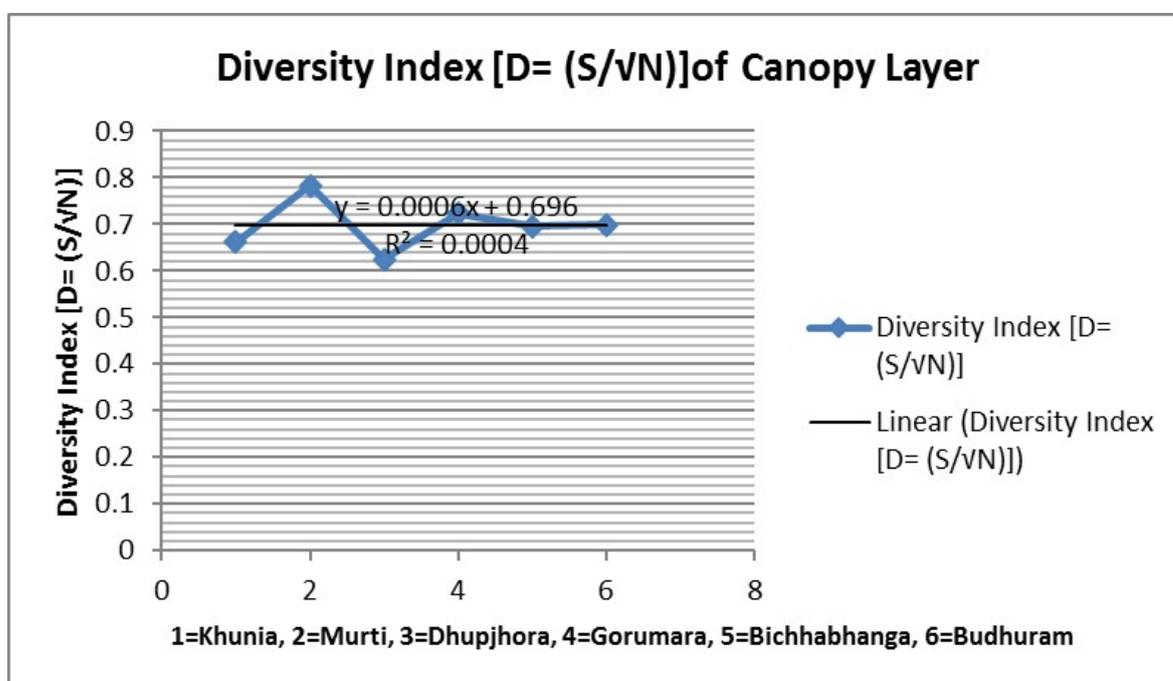


Fig. 10.11. Diversity Indices for the canopy layer vegetation in GNP

The determined diversity in canopy layer for different Forest Beat areas show quite high levels of diversity with Murti Beat recorded the highest (Fig. 10.11). Record of overall $D = 0.7$ is a quite high value. Like ground cover and shrub-layer, for canopy also Dhupjhora Beat scored the lowest Diversity Index value.

The highest Margalef Richness Indices (RI) has been recorded for the Murti Beat and the lowest value for Bichhabhanga Beat. However, as a whole, a high level of richness is maintained in the entire Gorumara National Park (Fig. 10.12).

Like ground cover vegetation, for canopy also quite a good number of species are recorded with the SDI value of 1.

Considering all these observations and Indices it is now clear that *Shorea robusta* forms the main skeleton for the forests of Gorumara National Park. However, a number of other species like

Actinidaphne obovata, *Alangium chinensis*, *Alstonia scholaris*, *Albizia chinensis*, *Casaeria vareca*, etc. is producing the picture of a mixed vegetation due to their high Abundance Index values.

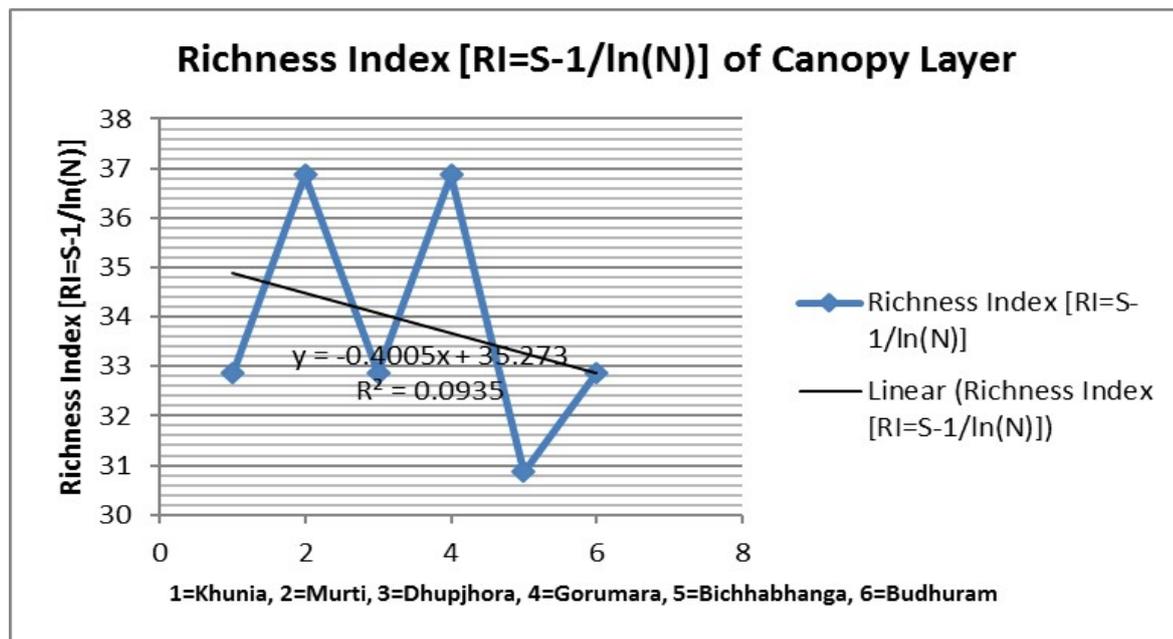


Fig. 10.12. The Richness Index for Canopy layer vegetation in GNP

In GNP all three major forest strata are with high Diversity and Richness values. But, the spread of some highly invasive shrubs exerting pressure on many local species. The authority need to develop some strategies to control the spread of these species otherwise low height plants and geophytes will be worst affected that is not desirable in any way!

10.3.1. Non-Timber Forest Produces

During the present study in GNP, survey for traditional uses of local plants was conducted from five different forest villages located on the periphery of GNP and in three local forest markets namely Lataguri Market, Dhupjhora Farm Market and Chalsa bazaar taking help of many local people, including collectors and practitioners. A total of 335 species of useful plants recorded of which 164 species are medicinal, 45 species ethnoveterinary medicinal, 57 species as vegetable or edible ripe fruits, 20 species used in various religious purposes, 2 species as spice, and 260 species used as fodder for their domestic animals (Fig. 10.13).

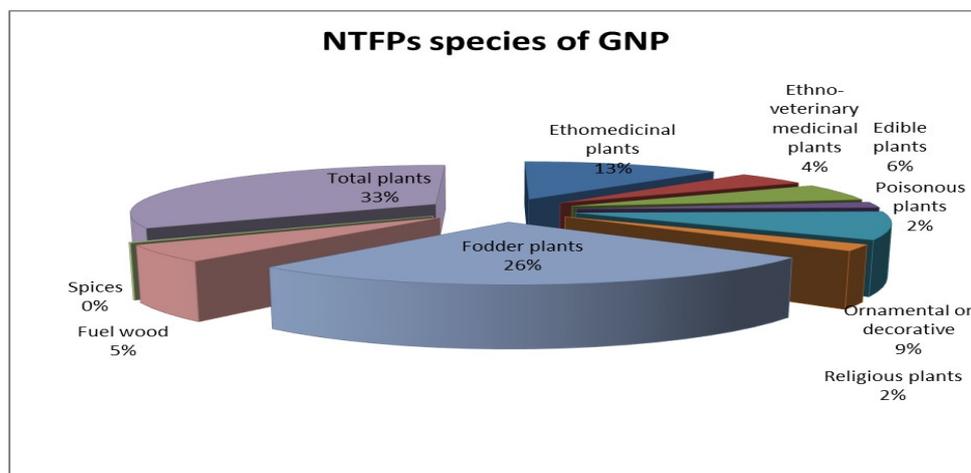


Fig. 10.13. Classification of NTFPs of GNP and its surrounding areas

No. of edible species with their used parts

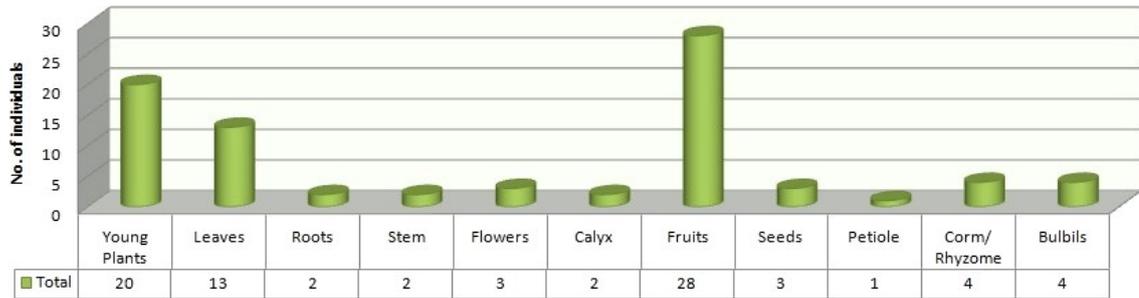


Fig. 10.14. Distribution of useful parts of the recorded edible plants of GNP

Many of the collected NTFPs are marketed locally. However traders are also involved despatching many such articles for different distant domestic markets where from some are also exported. Skilled collectors can collect those in proper stage and to the sustainable limit. It is also essential to impart proper training to the intended villages for this purpose. In addition, some such plants can be brought into the cultivation, especially the medicinal plants, so that the market demand can be fulfilled with best quality materials in one hand and the conservation of their wild population on the other. Villagers of the surrounding area will certainly be benefitted out of this. For fodder also through different wings of the Forest Department different types of fodders can be cultivated and can be provided to the farmers. This will save the biological diversity of the park.