Pleione 8(2): 320 - 330. 2014. **ISSN: 0973-9467**
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A sketch on the vegetation and its components of Mahananda Wildlife Sanctuary, Darjeeling District, West Bengal, India

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[Received 11.10.2014; Revised 14.12.2014; Accepted 16.12.2014; Published 31.12.2014]

Abstract

The present paper deals on the vegetation and its components of Mahananda Wildlife Sanctuary in Darjeeling district of West Bengal.

Key words: Mahananda wildlife Sanctuary, vegetation, floristic components.

INTRODUCTION

India, with an area of 32, 87, 263 km^2 has more than 6, 92, 027 km^2 under forest cover (India State of Forest Report 2011). The country is one of the twelve identified centers of origin of number of taxa which represent a wide array of Biodiversity. It is also a megadiversity country covering four Global Biodiversity Hotspots (Himalaya, Indo-Burma, Western Ghats & Sri Lanka and Sundaland) and several gene centers (Sen Sarkar & Roy 2012; Conservation International 2014). There are approximately 4.90 % of the total geographical area has been put under a program of conservation. As on November, 2014 there are 103 National Parks, 525 Wildlife Sanctuaries, 60 Conservation Reserves and 4 Community Reserves covering an area of 158645.05 km^2 of the total geographical area of India (www. wiienvis.nic.in).

Wildlife Sanctuaries are the natural protected areas and the main objectives of establishing sanctuaries are to provide *in-situ* conservation, which would help the biota to support all its life supporting system in a holistic manner.

The state of West Bengal lies between the Himalayas in the north and the Bay of Bengal in the south. It is only the state in India whose flora ranging right from the most impressive littoral forests of the Sundarbans to the luxuriant forests of the Himalayan foothills and the vegetation upwards culminating to the temperate and the alpine zone in the district of Darjeeling. The state has two natural divisions, the Himalayan in the northern part of the state comprising the districts of Darjeeling, Jalpaiguri and Cooch Behar, and the alluvial plain that lies in southern of it (Sanjappa *et al.* 2012). To its credit the state has 1 Biosphere reserve, 5 National Parks, 15 Wildlife Sanctuaries and 2 Tiger Reserves. Protected areas of West Bengal cover 4 % of the total state area. Forest cover including the forest created outside is 15.52 % of the geographical area of the state which is lower than national average of 23 % (www.wbbb.nic.in).

Botanical Survey of India, as a part of its action program is exploring, inventorying and documenting the phytodiversity in general and protected areas of India. Mahananda Wildlife Sanctuary, situated in the Darjeeling district, West Bengal has been explored and documentation has been done to know its Phytodiversity.

Study area

The Mahananda Wildlife Sanctuary (MWLS) is situated on the West bank of the River Tista in the Terai region of Darjeeling district that forms a part of the Eastern Himalaya, and located between latitudes $26^0$55´33" N and $26^0$47´54" N and longitude $88^0$33´31" E and $88^0$23´36" E. The notified area of the sanctuary is 127.22 sq km. It was first notified as a protected area during 1949. "Protection" at that time however was limited only to restrict the hunting of wild animals. The reserved forest in the lower catchment of Mahananda River had been declared as a Wildlife Sanctuary by Government of West Bengal in June 1976, under the administrative control of a Divisional Forest Officer. Major part of the sanctuary was brought under the administrative control of Wildlife Division I, Darjeeling by Principal Chief Conservator of Forests in November 1995, all the notified blocks of MWLS have been placed under the direct management of Wildlife wing on Reorganization of Forest Directorate in September, 1995 (Annonymous 1996).

The total area is divided into 33 forest blocks under four ranges viz. East, West, North and South range. The forest blocks are: Punding, Bandar jhola, Jogi jhora, Kuni, Choklong, Upper Champasari, Gulma valley, Silihhita, West Sevoke, East Sevoke, North Sevoke, Jhenaikuri, Lower Ghoramara, Upper Ghoramara, Gola, Ruyem, Andera, Chawa, Samaardanga, Lower Champasari, Singimari, Gulma, Mahanadi, Sukna (Part 1), Rongdong, Kaklong, Mohorganj, Panchenai, Hatisar, Kyananuka, Adalpur, Chumta and Laltong.

Topography and Ecological boundaries

The area of MWLS comprises of 60 % of the forest in hilly region in the foot hills of the Himalayas, characterized by moderate, steep to precipitous mountain slopes and high ridges towards the north and then sloping to almost flat stretch of the Terai and alluvial plains towards the south. There are two broad ecological subdivisions, the Hill tract and the Bhabar tract. Conversion of the higher hills into tea estates and Cinchona plantations have fragmented the ecological boundary in the north. River Tista in the east forms a physical barrier against movement of terrestrial wild lives of the Bhabar tract which is gently sloping and covered with sal forests. The river and khola belts act as valuable biotope for wildlife. The sal forest in the south forms an ecological continuum with Laltong block and Baikunthapur Division. A thin strip of forest makes the boundary in the rest of the portion in Hatisar, Mohorganj and Panchenai blocks. There are cultivated fields, labor colonies in the south. In the west, after the junction of Hill Cart Road and River Mahanada, the tea gardens and habitations limit the forest extant. (Anonymous 1996).

Soils

Soils of the sanctuary area are extremely varied depending upon the elevation and slopes. The basic soil types are yellow soils, red brown soils and brown forest soils. All the soils are definitely acidic in nature with the tendency to increase slighty in depth. Red and yellow soils have developed on gnesis while brown on schists and shales. The chemical content of the soil over gneiss is characterized by a high proportion of potassium derived from feldspar and muscovite mica. This soil is rich in lime, magnesium, iron oxides, phosphorus and nitrogen. (www.darjeeling.gov.in)

Climate

The climate of the MWLS is principally tropical and there are mainly three well marked seasons e.g. summer, winter and monsoon. The average minimum temperature recorded is 10.1º C and maximum temperature is 32.4º C (from 2003 – 2007). The average rainfall was 1141.1 mm per annum recorded from 1997 – 2006. The maximum rainfall is during June-

August and minimum in December and February. The relative humidity ranges recorded from 2003 – 2007 are 85.2 % - 91 %. (Climatological data from Environmental Research Station, Sukna, Darjeeling - personal communication).

VEGETATION OF THE SANCTUARY

The MWLS, a treasure house of biodiversity falls in the transition zone between Peninsular Indian sub-region and Indo-Malayan sub-region of the Oriental region. The phytogeographical position, irregular and undulated topography with lofty hill ridges and deep valleys accompanied by wide variation in climate and soil have resulted into the formation of varied rich and fascinating vegetation. According to the classification of biographic regions of India (Rodgers & Panwar 1988) these forests fall in zone 7, i.e. Gangetic plains, province 7B (Lower Gangetic plains), sub-divisions Bengal Duars. The forest type varies from riverian khair-sissoo forest to dense mixed-wet forest in higher elevation. The vegetation composition can be described under the following types:

Grass: This is the first seral stage of vegetation succession occur in river beds. This type occur in the clear land formed due to erosion and washing away of the forest cover by Tista River. The area is dominated by grasses mainly of *Phragmites karka* (Retzius) Trinius *ex* Steudel, *Saccharum bengalense* Retzius, *S. spontaneum* Linnaeus, etc.

Khair-Sissoo Forests: It is the second seral stage of vegetation in the plains found to grow near the banks of all rivers and larger streams. The area is dominated by *Albizia* spp., *Erythrina* sp., *Trewia* sp. The undergrowth consists of *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Mimosa himalayana* Gamble, *Saccharum spontaneum* Linnaeus, etc.

Simul-Siris Forests: The inland areas where soil formations have progressed, the vegetation is dominated by *Haldina cordifolia* (Roxburgh) Ridsdale, *Bischofia javanica* Blume, *Erythrina* sp., *Lagerstroemia parviflora* Roxburgh, *Tetrameles nudiflora* R. Brown in the top storey. The lower storey is composed of *Premna bengalensis* C.B. Clarke, *Mallotus philippensis* (Lamarck) Müeller- Argoviensis, etc. The undergrowth is composed of *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Lantana camara* Linnaeus, *Mimosa himalayana* Gamble, *Clerodendrum infortunatum* Linnaeus etc. The climbers are mainly of *Tinospora sinensis* (Loureiro) Merrill, *Dalbergia stipulacea* Roxburgh, *Clematis* spp. Small patches of this type of forests are found in North-Sevoke, Punding forest blocks, etc.

Sal Forests: After the previous type of forests, Sal occurs gregariously in deep loamy soil. The associates of Sal in the *East Himalayan lower Bhabar subtype* are different from those in the *East Himalayan upper Bhabar subtype*. *Eastern Bhabar subtype* can be further subdivided into Bamba Sal and Sevoke Sal. **(i) Bamba Sal** occurs in Lower Ghorama, Gulma valley, Choklong and Upper Champasari forest blocks. The associates of Bamba Sal are: *Schima wallichii* Choisy, *Garuga pinnata* Roxburgh, *Tetrameles nudiflora* R. Brown, etc. The under storey is composed of *Macaranga* spp., *Dillenia pentagyna* Roxburgh, *Careya arborea* Roxburgh, *Premna bengalensis* C.B. Clarke, etc. Ground flora includes *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Clerodendrum infortunatum* Linnaeus, *Coffea benghalensis* B. Heyne *ex* Schultz, etc. Climbers are rarely found. **(ii) Sevoke Sal** occurs in North Sevoke, West Sevoke and East Sevoke forest blocks. The Sal forest of this type is associated with *Terminalia crenulata* Roth, *Toona ciliata* M. Roemer, *Chukrasia tabularis* A. Jussieau, etc. Undergrowth is dominated by *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Leea* spp., *Coffea benghalensis* B. Heyne *ex* Schultes, *Clerodendrum infortunatum* Linnaeus, *Urena lobata* Linnaeus, etc. Climbers are *Bauhinia vahlii* Wight & Arnott, *Mikenia* sp., *Milletia* spp. Eastern Terai Sal type occurs in Shilibhita

blocks. This type occurs in wet areas with ferns and canes. The associates of Sal are *Lagerstroemia parviflora* Roxburgh, *Sterculia villosa* Roxburgh, *Haldina cordifolia* (Roxburgh) Ridsdale, *Garuga pinnata* Roxburgh, etc. The under storey is composed of *Bauhinia purpurea* Linnaeus, *Premna bengalensis* C.B. Clarke etc. The undergrowth is dominated by *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Clerodendrum infortunatum* Linnaeus, etc. Climbers are *Bauhinia vahlii* Wight & Arnott, *Parthenocissus* spp.

Dry Mixed Forest: Sal is common in this forest. The associates are *Dillenia pentagyna* Roxburgh, *Careya arborea* Roxburgh, *Terminalia crenulata* Roth, *Gmelina arborea* Roxburgh, *Lagerstroemia parviflora* Roxburgh, *Albizia* spp. The lower story is composed of *Ocotea lancifolia* (Schott) Mez, *Alstonia scholaris* (Linnaeus) Robert Brown, *Macaranga* spp., *Cinnamomum tamala* (Buchanan-Hamilton) T. Nees & Ebermaier, etc. The undergrowth is composed of *Ageratum* spp., *Clerodendrum infortunatum* Linnaeus, *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Dendrocalamus hamiltonii* Nees & Arnott *ex* Munro, etc. The climbers are *Bauhinia vahlii* Wight & Arnott , *Mikania* sp., *Tinospora sinensis* (Loureiro) Merrill. This type is found in North Sevoke, West Sevoke, Lower Ghoramara, Gulma valley, Choklong, Jogijhora, Upper Champasari and Punding forest blocks.

Wet Mixed Forest: This type of forest occur in Samardanga, West Sevoke and Shlibhita forest blocks. The species are found to grow like *Dillenia indica* Linnaeus, *Eugenia* spp., *Tetrameles nudiflora* Robert Brown The lower storey is composed of *Callicarpa arborea* Roxburgh, *Wrightia arborea* (Dennstedt) Mabberley, *Premna bengalensis* C.B. Clarke. *Macaranga* spp. Ferns and cane breaks are common. Climbers are *Tinospora sinensis* (Loureiro) Merril, *Mikania* sp., *Piper* spp., *Cissus* sp., etc.

Hill Forests: Hill forests can be grouped into *Lower hill forests* (up to 800 m elevation) and *Middle hills forests* (800 m and above). Lower hill forests can be grouped into (i) Lower hill Sal forests, (ii) Lower hill dry mixed forests, and (iii) Lower hill wet mixed forests.

(i) ***Lower hill Sal forests***: This type of forest is found to grow in Gulma valley, Punding, Jogijhora, Gola, Chawa and Ruyem forest blocks. The Sal forest is associated with *Schima wallichii* Choisy, *Terminalia crenulata* Roth, *Lagerstroemia parviflora* Roxburgh, *Careya arborea* Roxburgh, etc. The lower storey is composed of *Macaranga* spp., *Castanopsis* spp., *Ocotea lancifolia* (Schott) Mez, *Ficus* spp., etc. The undergrowth consists of *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson, *Clerodendrum infortunatum* Linnaeus, etc. Climbers are *Bauhinia vahlii* Wight & Arnott, *Mucuna* sp., *Parthenocissus semicordata* (Wallich) Planchon, etc.

(ii) ***Lower hill dry mixed forests***: The forest blocks like Chawa, Gola, Upper Ghoramara, Kuhi, Bandarjhola and Andera comprises of this type of forests. The dominant species are *Toona ciliata* M. Roemer, *Terminalia crenulata* Roth, *Tetrameles nudiflora* Robert Brown, *Castanopsis* spp. The lower storey comprises of *Bauhinia purpurea* Linnaeus, *Wrightia arborea* (Dennstedt) Mabberley, *Mallotus philippensis* (Lamarck) Müeller-Argoviensis, *Pterospermum acerifolium* (Linnaeus) Willdenow etc. The ground flora is composed of *Chromolaena odorata* (Linnaeus) R.M. King & H. Robinson *Clerodendrum infortunatum* Linnaeus, *Leea* spp., *Coffea benghalensis* B. Heyne *ex* Schultes, ferns and canes. The climbers are *Tinospora sinensis* (Loureiro) Merril, *Clematis* pp., *Mikania* sp. etc.

(iii) ***Lower hill wet mixed forests***: This type of forests occur in small patches in moist areas along Mahananda slopes, banks along the Jogijhora, Gulma, Ghoramara and Choklong etc. The dominant species are *Acrocarpus fraxinifolius* Arnott, *Toona ciliata* M. Roemer, *Cinnamomum* spp., *Duabanga grandiflora* (de Candolle) Walper, *Callicarpa candicans*

(Burman f.) Hochreutiner, *Bischofia javanica* Blume, *Actinodaphne obovata* (Nees) Blume, *Pandanus* spp., canes and ferns. The climbers are *Tinospora sinensis* (Loureiro) Merril, *Parthenocissus semicordata* (Wallich) Planchon, *Cissus repanda* (Wight & Arnott) Vahl, *Bauhinia* spp., etc.

Middle hill forests (800 m and above): This type is found in Kuhi and Latpanchar forest blocks. The species are *Schima wallichii* Choisy, *Betula alnoides* Buchanon Hamilton *ex* D. Don, *Castanopsis* spp., *Phoebe attenuate* (Nees) Nees, *Acrocarpus Acrocarpus fraxinifolius* Arnott. The lower storey comprises of *Cinnamomum bejolghota* (Buchanan-Hamilton) Sweet, *Macaranga* spp., *Wrightia arborea* (Dennstedt) Mabberley, and bamboos in large patches. The thick under growth comprises of *Desmodium* spp., *Maesa* spp., ferns and epiphytes.

PLANTATIONS

Large areas are under plantations both in plains and hills within the sanctuary areas. Plantations in plain areas are mainly of Teak and Sal. The other species grown are *Lagerstroemia speciosa* (Linnaeus) Persoon, *Magnolia champaca* (Linnaeus) Baillon *ex* Pierre, *Schima wallichii* Choisy, *Bombax ceiba* Linnaeus, *Dalbergia sissoo* de Candolle, *Gmelina arborea* Roxburgh, etc. Plantations in lower hill forests are mainly of *Shorea robusta* Gaertner, *Tectona grandis* Linnaeus f., *Acrocarpus fraxinifolius* Arnott, *Amoora rohituka* (Roxburgh) Wight & Arnott, *Tetrameles nudiflora* R. Brown, *Gmelina arborea* Roxburgh, *Magnolia champaca* (Linnaeus) Baillon *ex* Pierre, and *Pinus* spp. There is a *Cinchona* plantation in 30 hectors of land at Latpancher.

PAST BOTANICAL WORK

It was Sir J.D. Hooker, who made extensive collections from erstwhile Bengal and especially from Darjeeling and Sundarbans. The botanical findings during his travels have been systematically recorded by him (Hooker 1849, 1850, 1852). Gamble (1875, 1878) also made rich collection from Darjeeling and foothills of Jalpaiguri. Various parts of Northern Bengal were subsequently explored by A.M. Cowan and J.M. Cowan and published a list of plants (1929). K.P. Biswas (1966) published the "*Plants of Darjeeling and Sikkim Himalayas*". I. H. Burkill (1916) published a note on the Terai forests between Gandak and the Tista. Das & Chanda (1987) published a flowering calendar of the Angiosperm flora of Darjeeling hills, West Bengal. Grierson, Long and Noltie (1983 – 2002) published the 'Flora of Bhutan' where they also included the plants of some areas of Mahananda Wildlife Sanctuary. A report on "Survey of Flora and Fauna of Mahananda Wild Life Sanctuary" was published in 1996 by Wildlife Wing, Forest Department, Govt. of West Bengal. In this report there is an enumeration of 170 plant species including trees (39 spp.), Herbs (55 spp.), Shrubs (54 spp.) and Climbers (22 spp.) of the area.

PRESENT BOTANICAL WORK

Field work: The MWLS covers an area of 127.22 km^2. Some of the area is in plain land but most of the areas are hilly tracts, ridges and deep furrows with some inaccessible areas. The inaccessible areas were surveyed on foot as far as possible. The work is the result of intensive botanical exploration tours in different seasons and herbarium consultations. All the seasons like summer, monsoon and winter covering herbaceous flora including grasses and sedges as well as arboreal flora etc. are covered. During field collections field notes like plant habit, habitat, colour of flower and fruit, phenology, frequency and abundance, exact

locality, altitude, plant associations etc. have been noted down. The plants were collected and pressed in the blotting papers for drying. They were tentatively identified in the field.

Herbarium work: The whole process of collection, pressing and preparation of herbarium sheets was in accordance to the conventional herbarium techniques (Jain & Rao 1977). Relevant field notes were entered and then identified with local floras, regional floras and recent monographs and confirmed by consulting authenticated herbarium sheets deposited at CAL as well as at NBU-Herbarium. All the earlier collections of this sanctuary preserved in CAL have also been consulted. The voucher specimens have been deposited at CAL.

FLORISTIC COMPOSITION

The floral analysis of the MWLS shows that Angiosperms have the maximum diversity in terms of species richness followed by Pteridophytes and Gymnosperms. A total of 584 taxa under 388 genera and 127 families have been collected and identified. Of the total taxa, dicotyledons comprise of 86 families, 288 genera and 434 species, monocotyledons comprise of 22 families, 73 genera and 102 species, gymnosperms comprise of 2 families, 2 genera and 2 species and pteridophytes comprise of 17 families, 25 genera and 46 species. Of the total 388 genera, dicotyledons represent 288 genera, monocotyledons by 73 genera, gymnosperms by 2 genera and Pteridophytes by 25 genera respectively (Tables 1 & 4). Out of total 584 taxa, dicotyledons represent 74.31 %, monocotyledons 17.46 %, gymnosperms 0.34 %, and pteridophytes 7.84 % of the flora (Table 2). The flora comprises of herbs 302 taxa, shrubs 105 taxa, climbers 68 taxa and trees 109 taxa.

Table 1. Quantitative analysis of the different taxonomic and habit groups in Mahananda wildlife sanctuary

	Angiosperms		**Gymno-sperms**	**Pterido-phytes**	**Total**
	Dicots	**Monocots**			
Families	86	22	2	17	127
Genera	288	73	2	25	388
Species	434	102	2	46	584
Trees	105	2	2	00	109
Shrubs	96	9	00	00	105
Herbs	176	80	00	46	302
Climbers	57	11	00	00	68

Table 2. Percentage-wise representation of different major taxa in the flora of MELS

Dicots	74.31%
Monocots	17.46%
Gymnosperms	0.34%
Pteridophytes	7.84%

The most dominating family in MWLS is Leguminosae (59 spp.), which is followed by Asteraceae (34 spp.), Poaceae (32 spp.), Rubiaceae (27 spp.), etc. (Table 3).

Besides the Indian elements, the flora of MWLS has exhibit the phytogeogrphical affinity with other floristic regions of the world. The representative species of North American elements from the study area include *Gnaphalium purpureum* Linnaeus, *Parthenium hysterophorus* Linnaeus, *Tithonia diversifolia* (Hemsley) A. Gray, *Argemone mexicana* Linnaeus, etc.; Neotropical elements or plants of tropical American region occurring in MWLS

Table 3. Ten most dominant families arranged in descending order of number of taxa

Sl. No.	Family	No. of taxa
1.	Leguminosae	59
2.	Asteraceae	34
3.	Poaceae	32
4.	Rubiaceae	27
5.	Euphorbiaceae	20
6.	Scrophulariaceae (including Linderniaceae)	18
7a	Lamiaceae	16
7b.	Acanthaceae	16
8.	Orchidaceae	14
9	Cyperaceae	13
10a.	Verbenaceae	11
10b.	Malvaceae	11

represented by *Ageratum conyzoides* (Linnaeus) Linnaeus, *Lantana camara* Linnaeus, *Triumfetta rhomboidea* Jacqmont, *Urena lobata* Linnaeus, *Peperomia pellucida* (Linnaeus) Kunth, *Mimosa pudica* Linnaeus; South American elements are *Croton bonplandianus* Baillon, *Gomphrena celosioides* Martius, *Sida acuta* Burman f., *Senna alata* (Linnaeus) Roxburgh, *Senna tora* (Linnaeus) Roxburgh; African elements are *Cleome rutidospermum* de Candolle, *Ludwigia hyssopifolia* (G. Don) Exell, *Ludwigia erecta* (Linnaeus) Hara, *Cynodon dactylon* (Linnaeus) Persoon, *Emilia sonchifolia* (Linnaeus) de Candolle *ex* de Candolle; European species like *Oxalis corniculata* Linnaeus. The paleotropical elements occurring in the sanctuary area include *Achyranthes aspera* Linnaeus, *Cleome viscosa* Linnaeus, *Saccharum spontaneum* Linnaeus, etc. The Pantropical elements are *Ageratum conyzoides*, (Linnaeus) Linnaeus, *Alternanthera sessilis* (Linnaeus) R. Brown *ex* de Candolle, *Amaranthus spinosus* Linnaeus, *Boerhavia diffusia* Linnaeus, *Euphorbia hirta* Linnaeus, *Sida acuta* Burman f., *Cyanthillium cinereum* (Linnaeus) H. Robinson, etc. The cosmopolitan elements are *Chenopodium album* Linnaeus, *Cynodon dactylon* (Linnaeus) Persoon, *Cyperus rotundus* Linnaeus, *Oxalis corniculata* Linnaeus, *Triumfetta rhomboidea* Jacquemont, etc.

RARE, ENDANGERED & THREATENED SPECIES

Chakraverty *et al*. (1999) listed 37 rare and threatened taxa from West Bengal state of which 17 taxa are exclusively from Darjeeling district in which the Wildlife Sanctuary belongs to. Very few species had been described from the sanctuary areas and nearby. *Cissus spectabilis* (Hochstetter) Planchon (Vitaceae) was described from Sikkim Terai and was once collected from Siliguri on 1875, a nearby area of the Sanctuary. This species is mentioned as 'endangered' by Shetty & Singh (Red Data Book of Indian Plants 3: 261. 1990). *Ixora anthroantha* (Rubiaceae) described by Bremekamp collected by M.V. Laurie from Sukna in 1940; *Osbeckia darjeelingensis* G.S. Giri & M.P. Nayar (Melastomataceae) collected from Jhenaikuri, Darjeeling by J.S. Gamblein 1879. Sanjappa *et al.* (2012) published a list of 19 species which are not collected after type collection in West Bengal of which 14 are from Darjeeling and Jalpaiguri districts.

The species like *Geissaspis cristata* Wight & Arnott (Fabaceae; Das *et al*. 2008), *Hyptis brevipes* Poiteau (Lamiaceae; Banerjee & Maiti 2011), *Cheirostylis yunnanesis* Rolfe (Orchidaceae), *Helicteres plebeja* Kurz (Sterculiaceae) are found in very few populations in the Mahananda wildlife sanctuary area.

A conspectus of families showing number of genera and species collected from Mahananda wildlife sanctuary: In the present work, families are delimited following the Bentham and Hooker's (1862 – 1883) system of classification. List of families are arranged Table 4 after Bentham & Hooker (1862-1883), Verma & Kumar, (1997); and for the families of Pteridophytes are arranged after Pichi Sermoli (1977, 1982).

Table 4. List of vascular plant families representing in the flora of Mahananda Wildlife Sanctuary along with their number of genera and species.

Family	Genus	Species		Family	Genus	Species
Ranunculaceae	2	2		Sapindaceae	2	2
Dilleniaceae	1	2		Sabiaceae	1	1
Magnoliaceae	2	3		Anacardiaceae	2	2
Annonaceae	2	2		Moringaceae	1	1
Menispermaceae	3	3		Leguminosae	32	59
Papaveraceae	1	1		Rosaceae	3	4
Brassicaceae	2	2		Combretaceae	2	5
Capparaceae	4	7		Myrtaceae	2	4
Violaceae	1	1		Lecythidaceae	1	1
Flacourtiaceae	1	1		Melastomataceae	2	4
Polygalaceae	1	1		Lythraceae	3	4
Caryophyllaceae	2	2		Sonneratiaceae	1	1
Clusiaceae	1	1		Onagraceae	1	3
Theaceae	1	1		Passifloraceae	1	2
Actinidiaceae	1	1		Caricaceae	1	1
Dipterocarpaceae	1	1		Cucurbitaceae	5	5
Malvaceae	6	11		Begoniaceae	1	5
Bombacaeae	1	1		Apiaceae	1	1
Sterculiaceae	5	6		Araliaceae	2	2
Tiliaceae	2	4		Alangiaceae	1	1
Balsaminaceae	1	2		Rubiaceae	22	27
Oxalidaceae	2	3		Asteraceae	27	34
Averrhoaceae	1	1		Lobeliaceae	1	2
Rutaceae	5	5		Primulaceae	1	1
Ochnaceae	1	1		Myrsinaceae	2	3

Family	Genus	Species		Family	Genus	Species
Burseraceae	1	1		Symplocaceae	1	2
Meliaceae	6	6		Oleaceae	1	1
Icacinaceae	1	1		Apocynaceae	6	6
Aquifoliaceae	1	1		Asclepiadaceae	4	4
Rhamnaceae	2	3		Buddlejaceae	1	1
Vitaceae	3	7		Gentianaceae	1	1
Leeaceae	1	1		Boraginaceae	2	2
Convolvulaceae	4	9		Dioscoreaceae	1	4
Solanaceae	4	8		Liliaceae	1	1
Scrophulariaceae	9	18		Asparagaceae	1	1
Orobanchaceae	1	1		Haemadoraceae	1	1
Gesneriaceae	3	3		Hypoxidaceae	2	2
Bignoniaceae	1	1		Smilacaceae	1	2
Pedaliaceae	1	1		Pontederiaceae	2	2
Acanthaceae	13	16		Commelinaceae	4	9
Verbenaceae	6	11		Arecaceae	2	2
Lamiaceae	10	16		Pandanaceae	1	1
Amaranthaceae	7	10		Araceae	5	5
Chenopodiaceae	1	1		Alismataceae	1	1
Phytolaccaceae	1	1		Cyperaceae	4	13
Polygonaceae	1	8		Poaceae	23	32
Piperaceae	2	5		**Pteridophyte**		
Lauraceae	5	8		Huperziaceae	1	1
Euphorbiaceae	11	20		Lycopodiaceae	1	1
Cannabaceae	1	1		Selaginellaceae	1	2
Moraceae	1	4		Equisetaceae	1	2
Urticaceae	5	13		Polypodiaceae	6	11
Juglandaceae	1	1		Schizaceae	1	1
Betulaceae	1	1		Cryptogramma-ceae	1	2
Taxodiaceae	1	1		Adiantaceae	1	3
Podocarpaceae	1	1		Hemionitidaceae	1	1
Hydrocharitaceae	1	1		Vittariaceae	1	2

Family	Genus	Species		Family	Genus	Species
Orchidaceae	14	14		Dennstaedtiaceae	1	2
Zingiberaceae	4	6		Pteridaceae	3	8
Costaceae	1	1		Thelypteridaceae	1	4
Marantaceae	1	1		Woodsiaceae	1	1
Musaceae	1	1		Dryopteridaceae	2	3
Amaryllidaceae	1	1		Oleandraceae	1	1
Iridaceae	1	1		Davalliaceae	1	1

CONCLUSIONS

Mahananda Wildlife Sanctuary, a treasure house of biodiversity, situated in the Darjeeling district of West Bengal, India. The forest types vary from riverain Khair-Sissoo forest to dense mixed-wet forest in higher elevation. A total of 584 taxa under 388 genera and 127 families has been recorded from the study area. In the study area Asteraceae is the largest among the Dicots and Poaceae is the largest among the Monocot. The area is also having similarity in its species composition with those of Indo-African elements, South and North American elements, Neotropical elements, Pantropical elements, Pennisular elements and elements occurring widely in rest of India. The current pressure of developmental activities around the sanctuary areas, illegal felling of tree species, collection of plants for fire wood, activities through ecotourism, illegal encroachment of forest land have a great impact on the components of biodiversity including habitat destruction, over exploitation, increasing pollution, etc. Adequate enforcement of regulatory measures is called for.

Acknowledgements

Authors are thankful to the Director, Botanical Survey of India, Kolkata for all facilities. They are also thankful to Prof. A. P. Das, North Bengal University, Siliguri for his valuable suggestions. Thanks are due to West Bengal Forest Department, Kolkata for providing permission and necessary help in field collections.

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