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Phytodiversity (Angiosperms and Gymnosperms) in Chaurangikhal forest of Garhwal Himalaya, Uttarakhand, India

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Abstract

We report the phytodiversity richness of the moist temperate Chaurangikhal forest of Garhwal Himalaya, Uttarakhand, India. We recorded a total of 231 species (227 angiosperms and 4 gymnosperms) belonging to 69 families (67 angiosperms and 2 gymnosperms) and 159 genera (156 angiosperms and 3 gymnosperms). The dicotyledones and monocotyledones were represented by a total of 62 and 5 families, respectively. In the study area, the ratio of family to genus was 1: 2.3, family to species was 1: 3.35 and a genus to species was 1: 1.45. Among all the species recorded the 88.31% (204 spp.) of the total species had common occurrence, whereas rest 11.69% (27 spp.) of the species had uncommon occurrence in the study area. The 10 dominant families of the study area were Lamiaceae, Asteraceae, Rosaceae, Ranunculaceae, Fabaceae, Caryophyllaceae, Polygonaceae, Rubiaceae, Gentianaceae and Poaceae. This data may be useful for biodiversity managers and for optimal utilization of plant resources.

Keywords: India, phytodiversity, floristic composition, plant distribution, Garhwal Himalaya, moist temperate forest.

Introduction

Vegetation is the most precious gift, nature has provided to us, as it is meeting all kinds of essential requirements of the humans in the form of food, fodder, fuel, medicine, timber, resins, and oil, etc. (Gaur, 1999). Plant community plays a pivotal role in sustainable management by maintaining biodiversity and conserving the environment (Farooquee & Saxena, 1996). The knowledge of the floristic composition of a plant community is a prerequisite to understand the overall structure and function of any ecosystem. The living world is composed of more or less distinct entities which are called species. They represent an important level of integration in living nature (Venu, 2002). Fundamental botanical research revolves around floristic (listing of all plants of a given area) and mono-graphic (study of a plant group for its entire range of distribution) works. A flora enumerates plants of a particular geographical area with a purpose to identify them (Venu, 2002).

The Indian subcontinent, with its rich biodiversity, is one of the 12 mega-diversity countries in the world. The Eastern Ghats, Western Ghats, Himalayas, North-eastern hills and Andamans constitute important biodiversity areas of India. Montane Himalayan forests are the most biologically diverse habitats. The Indian Himalayan region occupies a special place in the mountain ecosystems of the world. These geodynamically young mountains are not only important from the stand point of climate and as a provider of life, giving water to a large part of the Indian subcontinent, but they also harbour a rich variety of flora, fauna, human communities and cultural diversity (Singh, 2006). The Himalayan mountain system covers only 18% of the geographical area of India, but accounts for more than 50% of India's forest cover and for 40% of the species endemic to the Indian subcontinent. About 64% of total geographical area of Uttarakhand is covered with forest (FSI, 2003). The fascinating flora of Northwest Himalaya with different topographic and climatic zones has attracted attention of several professional botanists, environmentalists and people of other walks viz. medical practitioners, engineers, surveyors, foresters, naturalists, etc. The Northwest Himalaya has long been recognized as a distinct floristic region in India (Hooker, 1906). Owing to varied topography, wide altitudinal range and unique

Fig. 1. Map of the study area.

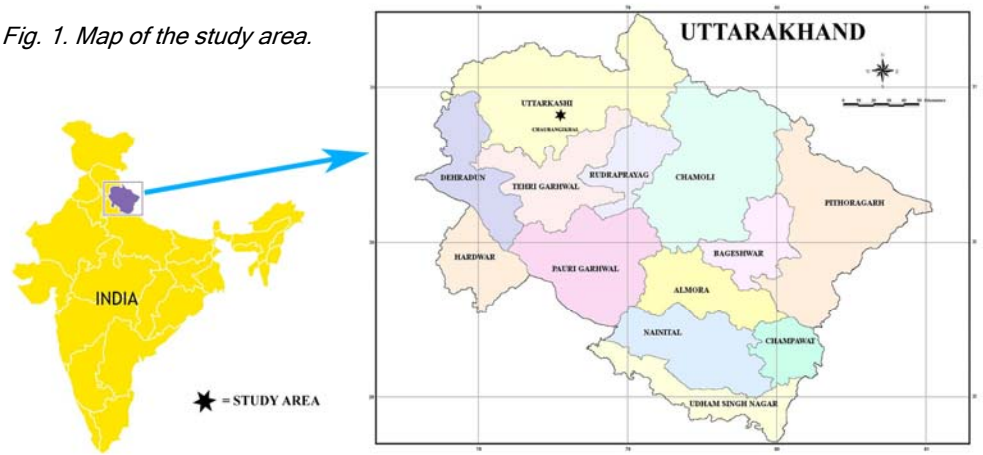

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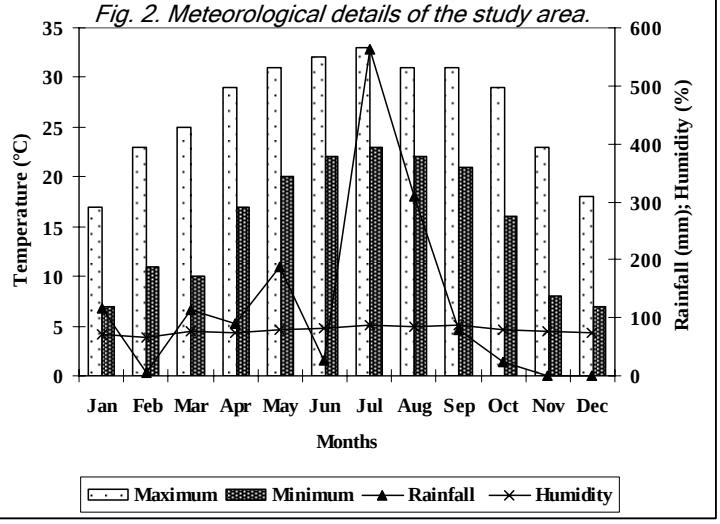
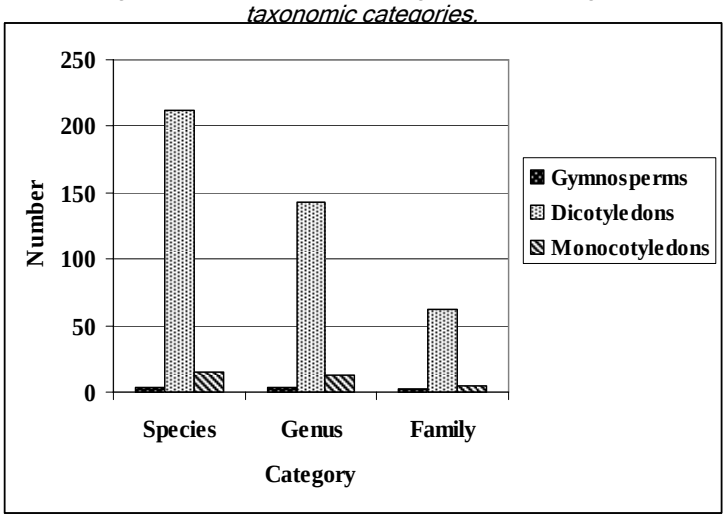
Fig. 2. Meteorological details of the study area.



geographical location, this region harbours a rich flora and exhibits affinities with the Mediterranean, Siberian,

Fig. 3. Distribution of different groups according to taxonomic categories.



Tibetan and Indo-Malayan regions. Paleobotanical evidences indicate that many of the woody elements in the flora of the Himalayan region owe their origin from the tropical wet evergreen climate of the Indian peninsula. The Indian Himalayan region is considered as the repository of biological and cultural diversity and supports about 18,440 species of plant, including 1748 species of medicinal plants and 675 species of wild edibles (Negi & Gaur, 1994). The representative biodiversity rich areas of the IHR have been protected through a protected area network (PAN). At present there are 5 biosphere reserves, 28 national parks, and 98 wildlife sanctuaries in IHR covering 51,899.238 km^2 (Mathur *et al.,* 2000).These protected areas are distributed in tropical, temperate, and alpine Himalayan ecosystems.

The concern grew on paramount after the constitution of "World Commission on Environment and Development (WCED) by the general assembly of the UN. This endorsed the need of conserving the world's rich biodiversity particularly that of the tropical areas. The "Earth Summit" a global convention held at Rio De Janerio (1992) under the auspices of United Nations Commission on Environment and Development (UNCED) laid stress on the integration, conservation and sustainable use of biodiversity. The biodiversity convention was ratified by 104 countries by adopting 42 articles as future course of action. One of the prerequisite tasks expressed by article 7 of the convention is the "identification and monitoring the components of biological diversity" while article 12 calls for research and training and suggests programme for identification, conservation and sustainable use of biological diversity. Documenting basic patterns of biodiversity is fundamental for priotizing areas for conservation and management action (Villasenor *et al*., 2007). Recently study on forest composition, diversity and socio-economic status in the Garhwal and study area has been done by Sharma & Gairola, 2007; Gairola *et al*., 2009a,b; Sharma *et al.,* 2009a,b,c; Sharma *et al.,* 2010. The Chaurangikhal forest is very rich in plant diversity and enumeration of plant wealth of this area has not been done so far. Therefore, in this study we have tried to list the flora of this forest covering all the important aspects of the phytodiversity (angiosperms and gymnosperms) of the study area.

Study area

Chaurangikhal forest is a part of the Mukhem forest division in Uttarkashi district of Uttarakhand. Its main station, Chaurangikhal is situated 29 Km away from Uttarkashi town. The temples of Chaurangi Nath Baba and Nachiketa Bhagwan are well known tourist attraction of the area. The forest area covers an altitudinal range of 1650 m asl to 2800 m asl and is situated at latitude 30° 39.125' N and longitude 78° 31.156' E (Fig. 1). Meteorological details of the study area are shown in Fig. 2. At Chaurangikhal station (situated at 2310 m asl), nearly 80% of the mean annual rainfall (1516 mm) in year 2006-07 occurred in the monsoon season between June and September and 20% fells as snow in winter season, between December and March. In nearby Chaundiyar and Dikholi villages (at 1650 m asl), the temperature remains cool and pleasant round the year. Frost is common during winter season, while the higher elevations (Harunta Bugyal at 2700 m asl and Thang area at 2550 m asl) experience heavy spells of snowfall, which may persist up to April-May in shady locations. Mean minimum monthly temperature ranged from 7.12°C (Jan) to 23.20°C (Jul) and mean maximum monthly temperature ranged from 17.56°C (Jan) to 33.35°C (Jul) in the year 2007.

Methodology

Extensive field surveys were conducted in the study area from May 2006 to April 2009 in different seasons (rainy, winter and summer) to assess the diversity of higher plants (gymnosperms and angiosperms) including

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Table 1. Inventory and other information about higher plants (angiosperms & gymnosperms) of the study area

Family/Species	Vernacular Name	LF	Altitude (m asl)	Oc	Habitat	Distribution in Himalaya
Acanthaceae						
Barleria cristata L.	Saundi,Kala-bansa	H	1600-1800	C	SM, OS	SUH, MH
Pteracanthus alatus (Clarke) Bremekamp	Jaunya, Pathora	H	1600-2200	C	SM, WS	WH
Strobilanthes atropurpureus Nees	Kangdai, Totna	H	1500-2000	C	SM, WS	NWH, MH, AH
Aceraceae						
Acer acuminatum Wall. ex D.Don	Rath-Kanchula	T	2000-2900	C	SM	MH
Amaranthaceae						
Achyranthes bidentata Blume	Latjiri, Chirchira	H	1600-2200	C	SM, UF, BO	MH, SUH
Cyathula capitata Moq.	Arsila	H	1600-2500	C	WS, CF,SM	MH, SUH
Apiaceae						
Bupleurum falcatum L.	Jangli-jeera	H	1600-2500	C	SM, WS, WP	SUH, MH
Centella asiatica (L.) Urban	Brahmi-buti	H	1600-2200	UC	WC, SM, WS, RS	SUH, MH
Pimpinella diversifolia DC.	Teroi, Phoree	H	1600-2600	C	SM, WS, RS, WP, CF	SUH, MH
Araliaceae						
Hedera nepalensis K.Koch	Laguli, Mithiari	Cl	1600-2500	C	EP, UF, SM, WS, RS	TH
Asclepiadaceae						
Cryptolepis buchananii Roem. & Schult.	Dudhi-Bel, Meda-inghi	Cl	1600-2600	C	EP, WS, UF	SUH
Asteraceae						
Ainsliaea aptera DC.	Kauru, Khad-Jari	H	1700-2700	C	SM, UF, BO	MH, AH
Ainsliaea latifolia (D.Don)	Kauru	H	1700-3000	C	SM, UF, BO	MH, SUH, AH
Anaphalis contorta (D.Don) Hook.f.	Bugla, Buglya	H	1600-2000	C	OP, WS, UF, SM	MH, AH
Anaphalis triplinervis (Sm.) Cl.	Bugla, Buglya	H	1600-2800	C	OP, WS, UF, SM	MH, AH
Artemisia vulgaris Auct. Non L.	Dona, Kunjaa	H	1650-2650	C	OP, WS, UF, SM	WH
Bidens pilosa L.	Kumur, Kumra	H	1600-2200	C	RS, WS, CF, WP	SUH, MH
Cirsium verutum (D.Don) Sprengel	Kardra, Kandaya	H	1600-2000	C	UF, OS, RS, WS, WC	SUH, MH
Cirsium wallichii DC.	Kandeiya, Kandra	H	1600-2500	C	UF, OS, RS, WS, WC	SUH, MH
Cotinus coggygria Scopoli	Gad-tungla, Tungoi	S	1900-2800	C	UF, WS	WH
Erigeron sublyratus DC.	-	H	1850-2250	UC	WS, OS, CF	MH, AH
Erigeron multiradiatus (Lindl. ex DC.) Cl.	-	H	1600-2500	C	OS, UF, RS, BO	MH, AH
Eupatorium adenophorum Sprengel	Kharna, Bakura	S	1600-2300	C	CF, RS, WP, WS, SM, US	SUH, MH
Gerbera gossypina (Royle) Beauv.	Kapasi	H	1600-2500	C	SM, BO	NW, SUH, MH
Inula cappa (Buch.-Ham.ex D.Don) DC.	Tamagari, Athhu	S	1600-2500	C	CF, RS, WP, WS	SUH, MH
Inula cuspidata (DC.) C.B. Clarke	Jhuri, Pushkar	S	1600-2200	C	BO, WS, SM WC, UF	SUH, MH
Lactuca dissecta D.Don	-	H	1600-2800	C	CF, RS, WP, WS	WH
Senecio gracilis DC.	-	H	2550-2800	C	CF, WP, WS	WH
Senecio kunthianus Wall. ex DC.	-	S	1650-2750	C	WS, OS, CF, UF	WH
Senecio laetus Edgew.	-	H	1600-2200	UC	WS, OS, CF, UF	WH
Senecio nudicaulis Buch.-Ham. ex D.Don	Neelkanthi, Ratpati	H	1600-2200	C	OS, CF	SUH
Taraxacum officinale Weber	Kan-fulya, Dudhee	H	1600-2500	C	OS, WP, RS, WS, SM, WC, BO, CF	MH, AH
Balsaminaceae						
Impatiens sulcata Wallich	Chaul, Kwal	H	1600-2800	C	WS, BO	TH
Berberidaceae						
Berberis aristata DC.	Kingore, Kasmor	S	1600-2000	C	WS, RS, BO, CF	NWH
Berberis asiatica Roxb. ex DC.	Kingor, Kilmora	S	1600-2200	C	WS, RS, DS, OS, CF	NWH
Berberis lycium Royle	Kingor, Rasaut	S	1600-1700	UC	WS, RS	NWH
Betulaceae						
Alnus nepalensis D.Don	Utis	T	1700-2400	C	BO, WC, WS	SUH, MH
Betula alnoides Buch.-Ham. ex D.Don	Saur	T	1600-2400	C	BO, RS, WC, WS	MH
Boraginaceae						
Cynoglossum glochidiatum Wall. ex Benth.	Lichkura, Andhahuli	H	1900-2100	C	WS, CF,SM	SUH, MH
Budlegaceae						
Budleja paniculata Wallich	Phurpattia	S	1600-2500	C	WS, CF, BO	NWH
Buxaceae						
Sarcococca saligna (D.Don) Muell.-Arg.	Paliyala, Geru, Tiliara	S	1600-2150	C	WS, UF, CF, BO	MH
Caesalpiniaceae						
Caesalpinia decapetala (Roth) Alston	Kingari, Kunju	S	1600-1550	C	WS, CF, BO	SUH
Campanulaceae						
Campanula pallida Wall.	-	H	1600-2200	C	RS, WS, CF	SUH, MH
Caprifoliaceae						
Lonicera quinquelocularis Hardw.	Taknoi, Bad-kukura	S	1600-1900	C	RS, WS, CF, OS	SUH, MH
Viburnum cotinifolium D.Don	Bhatnoi, Guya	S	1750-2600	C	OP, WP, WS, SM, WC, CF	NWH
Viburnum cylindricum Buch.-Ham. ex D.Don	Tita, Lampatiya	S	1600-2800	C	UF, WS, BO	MH
Viburnum mullaha Buch.-Ham. ex D.Don	Maleo, Lat-titmolya	S	1600-3000	UC	UF, WS, BO	MH

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Caryophyllaceae	**(Table 1 continues)**					
Cerastium cerasoides L.	-	H	2450-2650	UC	CF, WS, RS, UF, SM	MH, AH
Cerastium glomeratum Thuillier	-	H	1600-3000	C	CF, WS, RS, UF, SM	MH, AH
Gypsophylla cerasoides D.Don	Bakarchee	H	1600-2700	C	BO, WS, SM WC, UF	TH
Sagina saginoides (L.) Karsten	-	H	2300-2700	C	WS, UF, CF, BO	TH
Silene edgeworthii Bocquet	Bakrolya	H	1600-2000	UC	WS, OS, CF, UF	MH, AH
Silene indica Roxb. ex Otth	-	H	2400-2700	UC	OS, W, CF	TH
Stellaria media (L.) Vill.	Badyalu	H	1500-3000	C	WC, CF, WS	SUH
Stellaria monosperma D.Don	-	H	1600-2600	C	WS, OS, CF, UF, RS	SUH
Chenopodiaceae						
Chenopodium album L.	Bathua, Bathu	H	1600-2500	C	UF, OS, WS, WC	TH
Coriariaceae						
Coriaria nepalensis Wallich	Makroli, Gangara	S	1600-2800	UC	UF, OS, WS, WC	TH
Cornaceae						
Benthamidia capitata (Wallich ex Roxb.) Hara	Bhamora, Therbal	T	1600-2500	C	SM, UF, BO	MH
Swida oblonga (Wall.) Sojak	Katkanai	T	1500-3000	UC	WS, UF, WC, SM	MH
Corylaceae						
Carpinus viminea Lindl	Chamkharik	T	1600-2000	C	UF, RS, SM	MH, SAH
Crassulaceae						
Sedum oreades (Decne.) Hamet	-	H	1800-2800	C	WS, CF, UF, SM	MH, SAH
Daphniphyllaceae						
Daphniphyllum himalayense (Benth.) Muell.-Arg.	Ratniyalu	T	1800-2500	C	UF, SM, RS	NWH
Dioscoreaceae						
Dioscorea deltoidea Wallich ex Grisebach	Harvish, Tarur	H	2350-2700	UC	WS, OS, CF	MH, AH
Dioscorea melanophyma Prain & Burkill	Mangaii	H	1600-2800	UC	UF, WS, CF	SUH
Dipsacaceae						
Dipsacus inermis Wallich	Phulee	H	1900-2500	C	WS, OS, CF	MH, AH
Ericaceae						
Gaultheria nummularioides D.Don	Bhwinla	H	1600-2700	C	RS, UF, BO, OS	MH, AH
Lyonia ovalifolia (Wall.) Drude	Anyar	T	1600-2500	C	SM, OS, WS, CF, RS, UF	MH
Rhododendron arboreum Sm.	Burans	T	1600-2300	C	SM, RS, WP, CF	MH
Euphorbiaceae						
Euphorbia hirta L.	Dudhi	H	1600-2300	C	CF, RS, WP, WS	TH
Euphorbia pilosa L.	Chuplya, Chounpalu	H	1850-2600	C	RS, WP, CF	WH
Excoecaria acerifolia F. Didr.	Dudhila, Phutkiya	S	1600-2500	C	SM, RS, WP, CF	WH, CNH
Fabaceae						
Crotalaria medicaginea Buch.- Hem.ex Roxb.	Ban methi, Gulabi	H	1600-2500	C	SM, RS, WP, CF	TH
Desmodium elegans DC.	Chamlai	S	1600-1800	C	SM, RS, WP, CF	SUH, MH
Desmodium microphyllum (Thunb.) DC.	Sunsuni	H	1600-1700	C	CF, WS, UF	TH
Flemingia fruticulosa Wallich ex Benth.	Churan	H	1600-2700	C	CF, RS, WP, WS	WH, SUH
Indigofera dosua Buch.-Ham. ex D.Don	Sakina	S	1600-1800	C	OS, UF	SUH, MH
Indigofera heterantha Wall. ex Brandis	Sakina, Kathi, Kathoj	S	1600-2000	C	SM, RS, WP, CF	SUH, MH
Trifolium repens L.	Tipatiya	H	1500-2500	C	OS, WS	MH, AH
Trigonella corniculata L.	Van methi	H	2500-2800	C	UF, BO, SM	WH
Fagaceae						
Quercus floribunda Lindl. ex Rehder	Tilonj, Moru	T	2500-2800	C	SM, WC	MH
Quercus leucotrichophora A. Camus	Banj	T	1600-2450	C	SM, WC	SUH, MH
Quercus semecarpifolia Sm.	Kharsu	T	2450-2800	C	SM, WC	MH
Flacourtiaceae						
Flacourtia indica (Burm.f.) Merrill	Kandai, Kangu	S	1600-2500	C	CF, RS, WP, WS	TH
Gentianaceae						
Crawfurdia japonica C.B. Clarke	Gimkolya	H	1600-2450	UC	EP, WS, UF	SUH, MH
Gentiana capitata Buch.-Ham. ex D.Don	-	H	1600-2800	C	UF, OS	NW, MH
Gentiana pedicellata (D.Don) Wall.	Chhoti buggi	H	1600-2700	C	UF, OS	SUH, MH
Gentiana stipitata Edgew.	-	H	1600-2700	C	UF, OS	NWH, MH
Swertia chirayita (Roxb. ex Fleming) Karsten	Chiraita	H	1500-1800	UC	WS, UF, OS	SUH, MH
Swertia cordata (G.Don) C.B. Clarke	Chirata	H	1800-2100	UC	WS, UF, OS	MH
Swertia paniculata Wall.	-	H	1500-2000	UC	WS, UF, OS	NWH, MH
Geraniaceae						
Geranium nepalense Sw.	Phori, Syunli	H	1600-2700	C	OS, UF	MH
Geranium ocellatum Cambess	Kaphlya	H	1600-2500	C	OS, UF, WS, RS	SUH, MH
Hydrangeaceae						
Deutzia compacta Craib	Mhujvar	S	1900-2800	C	WS, OS, CF	MH
Deutzia staminea R.Br. ex Wall.	Ghugtai	S	1600-2600	C	UF, OS	WH
Hypericaceae						
Hypericum elodeoides Choisy	Basanti	S	1600-3000	C	UF, OS	MH
Hypericum oblongifolium Choisy	Chaya, Chitroi	S	1600-1850	C	WS, UF, OS	NWH
Hypericum uralum Buch.-Ham. ex D.Don	Bhyoul	S	1600-2700	C	WS, RS, UF, OS	TH

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Lamiaceae	**(Table 1 continues)**					
Ajuga brachystemon Maxim.	Rathpathi	H	1600-2500	C	SM, RS, WP, CF	WH
Ajuga parviflora Benth.	Neelkanthi	H	1600-2700	C	SM, RS, WP, CF	TH
Clinopodium umbrosum (M.Bieb.) Koch.	Birchee	H	1600-2500	C	OS, WS, RS, CF	SUH, MH
Colebrookia oppositifolia Sm.	Bindu	S	1600-2400	C	SM, RS, WP, CF	TH
Elsholtzia flava (Benth.) Benth.	-	S	1600-2000	C	SM, RS, WP, CF	MH
Elsholtzia fruticosa (D.Don) Rehder	Pothi	S	1600-2500	C	SM, RS, WP, CF	MH
Elsholtzia pilosa (Benth.) Benth.	-	S	1600-2800	C	SM, RS, WP, CF	MH
Lamium album L.	Tilka	H	1700-2800	C	SM, RS, WP, CF	SUH, MH
Leucas lanata Benth.	Bis-kapra, Gumma	H	1600-2300	C	WS, CF, OS	WH
Mentha arvensis L.	Paudina	H	1600-2200	C	WS, WC, BO,SM	WH
Mentha sylvestris L.	Paudina	H	1600-2500	C	MH	WH
Micromeria biflora (Buch.-Ham. ex D.Don) Benth.	Ban-ajwain	H	1600-2100	C	OS, SM	SUH, MH
Origanum vulgare L.	Bantulsi	H	1600-2300	C	SM, RS, WP, CF	MH
Phylomis bracteosa Royle ex Benth	-	H	2500-2800	C	SM, RS, WP, CF	SUH, MH
Phylomis macrophylla Wall.ex Benth	-	H	2500-2800	C	SM, RS, WP, CF	SUH, MH
Plectranthus mollis (Aiton) Sperngel	-	H	1600-2500	C	WS, SM, BO, CF	WH
Prunella vulgaris L.	-	H	1600-2700	C	SM, RS, WP, CF	MH
Rabdosia rugosa (Wall. Ex Benth.) Hara	Chichri	S	1650-2600	C	SM, CF,WS	WH
Salvia lanata Roxb.	Ghanyajhar, Ghaniya	H	1600-2500	C	WS, OS, CF	MH
Salvia nubicola Wall. Ex Sweet	Ganya	H	1600-2200	C	WS, OS, CF	MH
Scutellaria repens Buch.-Ham	-		1800-2550	C	WS, OS, CF, UF	SUH, MH
Scutellaria scandens Buch.-Ham. ex D.Don	Kutlaphul	H	1600-2200	C	SM, RS, WP, CF	SUH, MH
Thymus linearis Benth.	Ban ajwain	H	2000-3000	C	OS, UF, SM	
Lauraceae						
Neolitsea pallens (D.Don) Memiyama & Hara ex Hara	Bilaru	T	1600-2200	C	SM, UF	SUH, MH
Persea duthiei (King ex Hook. F.) Kostermans	Kaula Sairi, Bhadrao	T	1600-2200	C	SM, UF	SUH, MH
Liliaceae						
Asparagus adscendens Buch.-Ham. ex Roxb.	Sharanoi, Kaunta	H	1600-2000	UC	WS, RS, DS, OS, CF	SUH, MH
Reinwardtia indica Dum.	Phiyunli	S	1600-1900	C	SM, RS, WP, CF	SUH, MH
Lythraceae						
Woodfordia fruticosa (L.) Kurz	Dhaula	S	1700-1550	C	SM, RS, WP, CF	SUH
Malvaceae						
Sida acuta Burm. F.	Karenti, Bariara	H	1650-2000	C	WS, OS, CF, UF	OH, SHB
Moraceae						
Ficus hederacea Roxb.	Beduli, Laduli	Cl	1600-2500	C	UF, SM	SUH, MH
Myricaceae						
Myrica esculenta Buch.-Ham. ex D.Don	Kaphal	T	1600-2200	C	SM, UF, WS, BO	MH
Myrsinaceae						
Myrisine semiserrata Wall.	Gaunta, Bains	S	1600-2500	C	WS, CF, OS	SUH, MH
Myrisine africana L.	Chupra, Pahariche	S	1600-2100	C	UF, SM	SUH, MH
Oleaceae						
Jasminum humile L.	Surmarchi, Pilichameli	S	1600-2800	C	BO, WS, SM WC, UF	WH
Jasminum officinale L.	Jai, Champa	Cl	1600-2300	C	WS, BO	WH
Orchidaceae						
Calanthe plantaginea Lindl.	-	H	1600-2200	C	SM, RS, WP, CF	MH
Goodyera fusca (Lindl.) Hook.f.	Guddara	H	2500-3000	C	CF, RS, WP, WS	MH, AH
Goodyera repens (L.) R.Br.	Girwara	H	1600-1900	C	SM	MH, AH
Herminium lanceum (Thunb. ex Sw.) Vujik	Jalya	H	1600-2500	C	SM, RS, WP, CF	MH, AH
Oxalidaceae						
Oxalis corniculata L.	Bhilmori	H	1600-2700	C	SM, RS, WP, CF	TH
Oxalis dehradunensis Raizada	Khatura	H	1600-2300	C	SM, RS, WP, CF	OH, SUH
Pinaceae						
Abies pindrow Royle	Raga	T	2400-2800	C	BO, SM, OS	MH, WH
Abies spectabilis (D.Don)	Morinda, Raga	T	2500-2700	UC	BO, SM, OS	MH
Pinus roxburghii Sarg.	Chir, Kulain	T	1600-1900	C	BO, DS	SUH, MH
Plantaginaceae						
Plantago depressa Willd.	Luhurya	H	1600-2100	C	SM, RS, WP, CF	WH
Plantago erosa Wall.	Luhurya, Lahyrya	H	1600-22000	C	SM, RS, WP, CF	MH, AH
Poaceae						
Synarundinaria anceps (Mitf.) Chao & Revoize	Saruru, Ringal	S	2400-2650	C	SM, WP, CF	WH
Cynodon dactylon (L.) Persoon	Dubla	G	1600-1850	C	SM, RS, WP, CF	TH
Paspalum paspalodes (Mich.) Scribn.	-		1850-2250	C	WS, CF, OS	WH, MH
Sinarundinaria falcate (Nees) Chao & Renoize	Gad-Ringal, Ringal	G	1500-2000	C	SM, RS, WP, UF	WH, MH
Thamnocalamus falconeri Hook.f. ex Munro	Dev-Ringal	G	1500-2000	C	SM, RS, WP, UF	MH
Thamnocalamus spathiflora (Trinius) Munro	Tham Ringal	G	2500-2000	C	SM, RS, WP, UF	WH, MH

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Polygonaceae	**(Table 1 continues.....)**					
Persicaria capitata (Buch.-Ham. ex D.Don) H.Gross	Kaflya	H	1600-2300	C	WS, SM, BO	SUH, MH
Polygonatum cirrhifolium (Wall.) Royle	Khakan, Medha	H	1600-2300	UC	SM, CF,WS	MH
Polygonatum verticillatum (L.) Allioni	Kantula, Mahameda	H	1600-2650	UC	SM, CF,WS	MH, AH
Polygonum capitatum Buch.-Ham. ex D.Don	-	H	1600-1900	C	WS, SM, BO, CF	WH, MH
Polygonum donii Meissn.	-	H	1600-2100	C	WS, SM, BO, CF	WH, MH
Polygonum pterocarpum Wall. ex Meissn.	-	H	1650-1900	C	SM, CF,WS	WH, MH
Rumex hastatus D.Don	Kilmori, Almoru	H	1600-2100	C	RS, WP, CF, DS	SUH, MH
Rumex nepalensis Spreng.	Khatur	H	1600-2300	C	WP, RS, CF, WP	MH, AH
Primulaceae						
Androsace rotundifolia Hardwicke	-	H	1600-2200	C	BO, RS, WC, WS	MH
Primula denticulata Sm.	Jalkutra	H	1800-2250	C	SM, WS, MP, BO, WC	MH
Ranunculaceae						
Anemone obtusiloba D.Don	Kanchphool, Kakrya	H	2500-2650	C	OP, WS, UF, SM	AH, MH
Anemone rivularis Buch.-Ham. ex DC.	Mirchilee, Angeli	H	1600-2500	C	WS, SM, CF	AH, MH
Anemone vitifolia Buch.-Ham. ex DC.	Mudeela	H	1850-2250	C	WS, SM, CF	AH, MH
Artemisia roxburghiana Wallich ex Besser	Kunjaa, Chamur	H	1650-2250	C	OP, WS, UF, SM	WH
Clematis barbellata Edgew.	Kanrya, Santai	Cl	1600-2000	C	UF	NWH
Clematis buchananiana DC.	Lagulia	Cl	1600-3000	UC	UF	MH, SUH
Clematis connata DC.	-	Cl	1600-3000	C	UF, OS, WS, WC	MH
Clematis montana Buch.-Ham. ex DC.	Kujju	Cl	1600-2500	C	UF, WS	MH, SUH
Delphinium denudatum Wall. Ex Hook.f.	-	H	1600-2400	C	WS, OS, CF	MH, SUH
Ranunculus laetus Wall. Ex D.Don	-	H	1600-2600	C	SM, OS, WS, CF	TH
Thalictrum cultratum Wall.	-	H	1500-2500	C	WS, SM, CF	TH
Thalictrum foliolosum DC.	Mamiri	H	1500-2500	C	WS, SM, CF	TH
Rhamnaceae						
Rhamnus virgatus Roxb.	Choudelu	S	1600-2200	C	WS, OS	SUH, MH
Rosaceae						
Agrimonia pilosa Ledebour	Lesukuri	H	1600-2800	C	UF, OS, SM	MH
Cotoneaster acuminatus Lind.	Cham-ruins	S	2450-2700	C	UF, OS, WS, WC	MH
Cotoneaster bacillaris Wallich	Ruins, Rensu	S	2000-2800	C	UF, OS, WS, WC	MH
Cotoneaster microphyllus Wall. Ex Lindl	Bugarchilla	S	1600-2500	C	BO, OS	MH
Duchesnea indica (Andr) Focke	Bhiun-kaphal	H	1600-2000	C	UF, WS	TH
Fragaria nubicola Lindl ex Lacaita	Gand-Kaphal	H	1600-2000	C	WS, SM, UF, OS	MH
Potentilla fulgens Wall. Ex Hook.	Bajradanti	H	2550-2800	C	OS, UF, SM	MH
Prinsepia utilis Royle	Bhenkuli	S	1600-2100	C	WS, OS, CF	MH
Pyracantha crenulata (D.Don) M. Roemer	Ghingaru	S	1600-2300	C	OS, WS	SUH
Pyrus pashia Buch. Ham. ex D.Don	Melu	T	1600-2200	C	UF, WS, SM, CF	SHB, MH
Rosa brunonii Lindl.	Kujju	Cl	1600-2300	C	OS, WS, RS	MH, SUH
Rosa macrophylla Lindl.	Ban-gulab	S	1600-2800	UC	SM, CF,WS, RS	MH
Rosa sericea Lindl.	Dhurkunja	S	2200-2700	C	OS	MH
Rubus biflorus Buch.-Ham.ex Smith	Hinsara, Achanoi	S	2200-2600	C	OS, WS, RS	MH, SUH
Rubus ellipticus Sm.	Hinssar,Hisalu,Hinshoi	S	1600-2300	C	OS, DS, WS, RS, CF	SUH, MH
Rubus foliolosus D.Don	Kala Hissar	S	1600-2350	C	OS, SM, WS, RS, CF	MH
Rubus nepalensis (Hook.f.) Kuntze	Gangoor	Cl	1600-2300	C	SM, WS	MH
Rubus niveus Thunb.	Anchu	S	1600-2200	C	OS, WS	MH
Rubus paniculatus Sm.	Kall-Hinsar	S	1600-2780	C	OS, WS	MH
Spiraea canescens D.Don	Jhar Mairala	S	1600-3000	C	WS, RS, OS	MH
Rubiaceae						
Galium aparine L.	Kuri	H	1600-2500	C	WS, UF, SM	MH, AH
Galium asperifolium Wall.	Leswakuri	H	1600-2500	C	WS, UF, SM	MH, AH
Galium elegans Wall.	Kutub, Manjeethee	H	1600-2500	C	CF, RS, WP, WS	MH, AH
Leptodermis lanceolata Wall.	Padera, Padar	S	1600-2000	C	WS, CF, OP	MH
Himrandia tetrasperma (Roxb.) Yamazaki	Kamoli, Ghara	S	1600-2300	C	UF, WS, RS	SUH
Rubia manjith Roxb. ex Fleming	Manjeet, Lichkuru	Cl	1600-2300	C	UF, WS, RS, CF	TH
Spermadictyon sauveolens Roxb.	Padera	S	1500-1700	C	RS, WS, OP	SUH, MH
Rutaceae						
Boenninghausenia albiflora (Hook.) Reichb. ex Meisn	Pishumar	H	1600-2700	C	UF, SM, WC	SUH, MH
Murrraya paniculata (L.) Jack	Machula, Kamini	S	1600-2200	C	RS	SHB
Skimmia anquetilia Taylor & Airy Shaw	Nairpatti, Patrang	S	1500-3000	C	WS, OS, CF, UF	MH
Zanthoxylum armatum DC.	Timroo	S	1650-1800	UC	WS, RS, SM	SHB
Saxifragaceae						
Bergenia ciliata (Haworth) Sternberg	Silpara	H	1600-2500	C	SM, UF, BO	NWH
Scrophulariaceae						
Hemiphragma heterophyllum Wall.	-	H	1800-2800	C	SM, OS, UF	MH
Verbascum thapsus L.	Akulbir, Kakri Tamakhu	H	1800-2500	C	OP, WP, WS, SM, WC, CF	SUH, MH
Simaroubaceae						
Picrasma quassioides (D.Don) Bennett	Karui, Kakra	S	1600-24000	UC	BO, DS	OH

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Smilacaceae	**(Table 1 continues....)**					
Smilax aspera L.	Kukardara	Cl	1500-2000	C	OS, WS, UF	MH, SUH
Solanaceae						
Solanum erianthum D.Don	Akra	S	1500-2000	C	RS, WS	SHB
Solanum nigrum L.	Makoi, Kirmoi	H	1500-2000	C	RS, WS	TH
Symplocaceae						
Symplocos paniculata (Thunb.) Miq.	Lodh	T	2000-2500	C	UF, SM	MH, SUH
Taxaceae						
Taxus baccata L.	Thuner	T	2200-2700	UC	UF, BO, SM	MH
Thymelaeaceae						
Daphne papyracea Wall. ex Steudel	Satpura	S	1600-2700	UC	UF, SM, WC	MH
Ulmaceae						
Ulmus wallichiana Planchon	Mairu	T	1600-2500	UC	UF, SM	WH, MH
Urticaceae						
Debregeasia salicifolia (D.Don) Rendle	Syanru	S	1600-2000	C	WS, CF,SM	SUH, MH
Girardinia diversifolia (Link) Friis	Bhainsya Kandali	H	1600-2200	C	RS, WS, CF	SUH, MH
Urtica ardens Link	-	S	1600-2500	C	OP, WP, WS, RS, SM, WC, CF	SUH, MH
Urtica dioica L.	Kandali	S	1600-2500	C	OP, WP, WS, RS, SM, WC, CF	MH, SUH, NWH
Valerianaceae						
Valeriana hardwickii Wall.	Shammia	H	1600-2200	C	SM, CF	MH
Valeriana jatamansii Jones	Balchhari, Sumaya	H	2200-2700	C	UF, BO, SM	MH
Verbenaceae						
Callicarpa macrophylla Vahl	Daiya, Bhirmoli	H	1600-1800	C	WC, SM, WS	SUH, MH
Lantana camara L.	Kuri-ghas, Laltenya	S	1600-2300	C	SM, RS, WP, CF	TH
Violaceae						
Viola betonicifolia Sm.	Vanfsa, Phori	H	1800-2500	C	UF, SM	SUH
Viola biflora L.	Vanfsa	H	2200-2700	C	UF, SM	AH, MH
Viola canescens Wall.	Vanfsa	H	1600-2000	C	WS, SM, CF	MH
Viola pilosa Blume	Vanfsa	H	1600-2000	C	WS, SM, CF	MH, AH
Viola serpens Wall. Ex Gingins	Kauru	H	1600-2200	C	OP, WP, WS, RS, SM, WC, CF	MH, AH
Vitaceae						
Parthenocissus semicordata (Wall.) Planchon	Laguli	Cl	1600-2800	C	BO, WS	SUH, MH, NWH
Vitis lanata Roxb.	Puraini	Cl	1600-2500	C	BO, WS, UF	MH
Zingiberaceae						
Hedychium spicatum Buch.-Ham.	Ban-Haldi	H	1600-2500	C	BO, WS, SM WC, UF	SUH, MH
Roscoea purpurea Smith	Kakoli	H	1850-2700	C	OS, WS, RS	MH

BO= Bouldry; C= Common; CF= Cultivated Fields; Cl= Climber; DS= Dry Slopes; EP= Epiphytes; G= Grass; H= Herb; LF= Life Form; Oc= Occurrence; OS= Open Slopes; PA= Parasite; RS= Roadside; S= Shrub; SM= Shady Moist; T= Tree; UC= Uncommon; UF= Under Forest; WC= Water Courses; WP= Waste Places; WS= Wayside. TH= Throughout Himalaya; AH= Alpine Himalaya, SUH= Subalpine Himalaya; SAH= Subalpine Himalaya; NWH= North-west Himalaya; MH= Montane Himalaya; WH= West Himalaya; OH= Outer Himalaya; SHB= Sub Himalayan belt; CH= Central Himalaya;

Table 2. Comparison of floristic diversity of the Chaurangikhal forest area with other floras

Flora	Source	F	G	S	Ratio (F:G)	Ratio (G:S)
Chaurangikhal, Garhwal, UK.	Present Study	69	159	231	1: 2.30	1: 1.45
Mandal-Chopta, Garhwal, UK.	Gairola *et al.,* 2009b	93	249	338	1: 2.68	1: 1.36
Chamoli Garhwal, UK	Naithani, 1984-1985	163	892	1934	1: 5.47	1: 2.17
Garhwal Himalaya, UK.	Gaur, 1999	189	978	2035	1: 5.17	1: 2.08
British India.	Hooker, 1872-1897	174	2346	14384	1: 13.48	1: 6.13
Mussorie, UK.	Raizada & Saxena, 1978	131	649	1219	1: 4.95	1: 1.88
Himachal Pradesh.	Chowdhery & Wadhwa, 1984	180	1093	3200	1: 6.07	1: 2.93
Bashahr, HP.	Nair, 1977	134	689	1579	1: 5.14	1: 2.29
Shimla, HP.	Collett, 1902	123	639	1326	1: 5.20	1: 2.08
Lahual-Spiti, HP.	Aswal & Mehrotra, 1994	79	353	985	1: 4.47	1: 2.80
Kullu, HP.	Sharma & Dhaliwal, 1997	126	504	930	1: 4.00	1: 1.85
Sirmour, HP.	Kaur & Sharma, 2004	139	544	898	1: 3.92	1: 1.65

UK= Uttarakhand; HP= Himachal Pradesh; F= Family; G= Genus; S= Species

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important medicinal plants. The specimens of each species were collected and identified with the help of floras (Naithani, 1984-85; Gaur, 1999) and existing herbaria of Botany department HNB Garhwal University (GUH), forest research institute (DD) and botanical survey of India, northern circle (BSD). After identification, the plants were arranged according to Bentham and Hooker's system of classification (1862-1883). Taxonomical categories-genera and species within the family were placed alphabetically and species were described with usual citations. Information about vernacular names, habitat, life form, altitudinal range and occurrence were collected for each species. The twelve types of habitats were identified in the study area viz., bouldery, cultivated fields, dry slopes, epiphytes, open slopes, parasite, roadside, shady moist, under forest, water courses, waste places and wayside. Occurrence was categorized into common and uncommon types.

Results

The results of the study are placed in the Table 1. A total of 231 species belonging to 159 genera and 69 families were recorded. Of these, gymnosperms were represented by 4 species, 3 genera and 2 families, dicotyledons by 212 species, 143 genera and 62 families and monocotyledons by 15 species, 13 genera and 5 families (Fig. 3). In the study area, the ratio of family to genera was 1: 2.30, family to species was 1: 3.35 and genera to species was 1: 1.45. Among all the species recorded the 88.31% (204 spp.) of the total species had common occurrence, whereas rest 11.69% (27 spp.) of the species had uncommon occurrence in the study area.

In gymnosperms, Pinaceae (3 species & 2 genera) was the dominant family. Among the families of angiosperms Lamiaceae was the dominant family with 23 species and 16 genera followed by Asteraceae (21 species & 13 genera), Rosaceae (20 species & 11 genera), Ranunculaceae (12 species & 6 genera), Fabaceae (8 species & 6 genera), Caryophyllaceae (8 species & 5 genera), Polygonaceae (8 species & 3 genera), Rubiaceae (7 species & 5 genera), Gentianaceae (7 species & 3 genera), Poaceae (6 species & 5 genera), Violaceae (5 species & 1 genera), Rutaceae (4 species & 4 genera), Orchidaceae (4 species & 3 genera), Caprifoliaceae (4 species & 2 genera), Ericaceae (3 species & 3 genera), Euphorbiaceae (3 species & 2 genera), Berberidaceae (3 species & 1 genera), Scrophulariaceae (5 species & 4 genera), Solanaceae (5 species & 3 genera), Asclepiadaceae (4 species & 4 genera), Brassicaceae (4 species & 4 genera), Ericaceae (4 species & 3 genera), Lauraceae (4 species & 3 genera), Moraceae (4 species & 1 genera) and Violaceae (4 species & 1 genera). Dominant genera of the study area was *Rubus* with 6 species followed by *Polygonum* & *Viola* (5 spp. each), *Clematis* & *Senecio* (4 spp. each), *Anemone, Berberis, Cotoeaster, Elsholtzia, Galium, Gentiana, Hypericum, Quercus, Rosa, Swertia* & *Viburnum* (3 spp. each). Genera whose two species were recorded in the study area were *Ainsliaea, Ajuga, Anaphalis, Cerastium, Cirsium, Desmodium, Deutzia, Dioscorea, Erigeron, Geranium, Goodyera, Indigofera, Inula, Jasminum, Mentha, Myrisine, Oxalis, Phylomis, Plantago, Rumex, Salvia, Scitellaria, Silene, Solanum, Stellaria, Thalictrum, Thamnocalamus, Urtica* and *Valeriana.*

Discussion

Tropical Montane Himalayan forests are characterized by strong gradients related to topography and manifest as differences in elevation, precipitation, humidity, soil type, slope, aspect, and radiation. Species adapt to these gradients in often contrasting ways, and their distribution depends on the characteristics that define their reproduction and survival (Young *et al.*, 2002). Trees, the most important functional group in the ecosystem, were most diverse at middle elevations, but species composition changes over multiple gradients. Forest communities are subject to periodic disturbances from landslides due to high precipitation and mountainous terrain (Veblen *et al.*, 1981). Because of disturbances and multiple gradients, montane Himalayan forests are extraordinarily complex spatially; thus, habitat diversity and species turnover are prominent attributes of this ecosystem. Lower montane Himalayan forest communities are similar to lowland forests; however, with increasing altitude, montane Himalayan species become more abundant and lowland species more rare.

Inventory and monitoring of biodiversity of any area is prerequisite for conservation and management planning. Hooker (1906) described Orchidaceae, Fabaceae, Poaceae, Rubiaceae, Euphorbiaceae, Acanthaceae, Asteraceae, Cyperaceae, Lamiaceae and Urticaceae as 10 dominant families of India, whereas recently Gairola *et al.* (2009b) recorded Asteraceae, Lamiaceae, Rosaceae, Orchidaceae, Poaceae, Urticaceae, Polygonaceae, Fabaceae, Ranunculaceae and Euphorbiaceae as 10 dominant families in Mandal-Chopta forest of Garhwal Himalaya. In Chaurangikhal forest area 10 dominant families were recorded as Lamiaceae, Asteraceae, Rosaceae, Ranunculaceae, Fabaceae, Caryophyllaceae, Polygonaceae, Rubiaceae, Gentianaceae and Poaceae. The comparative account of the ratio of the families with genera and genera with species of various floras with the Chaurangikhal forest area has been presented in Table 2. From the table, it is clear that these ratios are directly proportional to the biogeographic area. It is believed that out of over 1600 species of medicinal plants traditionally used in India (Uniyal *et al.,* 2002), more than 50% species come from the Himalayan region. About 2,500 wild plant species are reported in use for medicinal purposes in Indian sub-continent, of which, possibly about 300 taxa are used in 8,000 licensed pharmaceuticals in India (Ahmad, 1993). On the basis of our data, it is possible to affirm that there is high diversity of medicinal plants in the Chaurangikhal forest area. On the other hand, the importance of conservation of these medicinal plants is

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unquestionable, because this knowledge represents additional data for selecting plants that also should be used in studies focusing on ecosystem conservation.

Chaurangikhal forest was found to be very rich in phytodiversity. Unplanned use and habitat degradation may lead to depletion of the species from the area. Further, habitat wise monitoring of the species using standard ecological methods is suggested. The present study provides comprehensive information on species diversity, altitudinal and habitat wise distribution pattern of higher plants of the Chaurangikhal forest area. This study will be of great help to the state govt., particularly the forest dept. in developing a strategy and action plan for the management of this biodiversity rich forest area.

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