

## **AN ASSESSMENT OF FLORISTIC DIVERSITY OF GANDHAMARDAN HILL RANGE, ORISSA, INDIA**

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### **Abstract**

The plant resources of Gandhamardan hill range were studied and analysed. A total of 912 vascular species belonging to 556 genera under 142 families were recorded. Herbs dominate the flora followed by trees, climbers and shrubs. Dominance of phanerophytes indicates the tropical moist and humid climate. Proper conservation and management plans are needed to save the natural resources, especially medicinal plants, of this sacred hill range.

### **Introduction**

Knowledge of forest structure and floristics are necessary for the study of forest dynamics, plant-animal interactions and nutrient cycling. An aspect that has generated considerable attention for many years among ecologists as well as evolutionary and conservation biologists has been the analysis of the patterns, causes and maintenance of biological diversity in the tropics (Gentry, 1988; Huston, 1994). More recently, there has been an awareness of and an increasing interest in understanding the variation in species diversity within the tropics (Gentry, 1982, 1995). Tropical moist deciduous forests are the most diverse from the floristic point of view.

Gandhamardan hill range is such a tropical moist deciduous system in Orissa, India. Due to diversified topography with twenty-two perennial streams, the hill range having most congenial environment for the luxuriant growth of plant resources. These resources are under severe threat due to over-exploitation by the local people for collection of firewood, fodder and medicinal plants and heavy incidence of grazing. Some sporadic works on floristic and ethnobotanical studies were carried out earlier (Raju, 1960; Panigrahi *et al.*, 1964; Brahmam and Saxena, 1990a, b; Mishra *et al.*, 1994, 2001; Misra and Behera, 1998; Mishra and Das, 2003; Misra, 2004). But, this floristically rich hill range with varied terrain conditions and environmental factors along with its phytogeographical position was not explored well in the past.

The present study is, therefore, the first attempt to make an inventory and analysis of the entire flora of Gandhamardan hill range based on copious field observations, available literature and herbarium data, with a view to contribute to the overall knowledge of Gandhamardan flora and to the management of this sacred hill range.

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### Materials and Methods

Gandhamardan hill range (between 20°42' and 21°00' N latitude and 82°41' and 83°05' E longitude) stretches over 240 km<sup>2</sup> area in Bargarh and Bolangir districts of Orissa, India. The hills are believed to be of ancient age and sacred because legend says, when Hanuman carried the mountain from Himalayas to Sri Lanka in search of *Sanjivani*, some part of it fell down in Orissa. There are two temples (Nrusinghnath and Harishankar) of 11<sup>th</sup> century based in the foothills on the northern and southern parts of the plateau on the bank of two perennial streams. The hill ranges are composed of a cluster of hills with altitude varying between 600 and 1005 m. Bender, Butel, Chalidilli, Chhatradandi Gandhamardan, Potpani and Thuta are the prominent hills in this area. The range stands as a natural barrier at the border of Bolangir and Bargarh districts of Orissa (Fig. 1). This

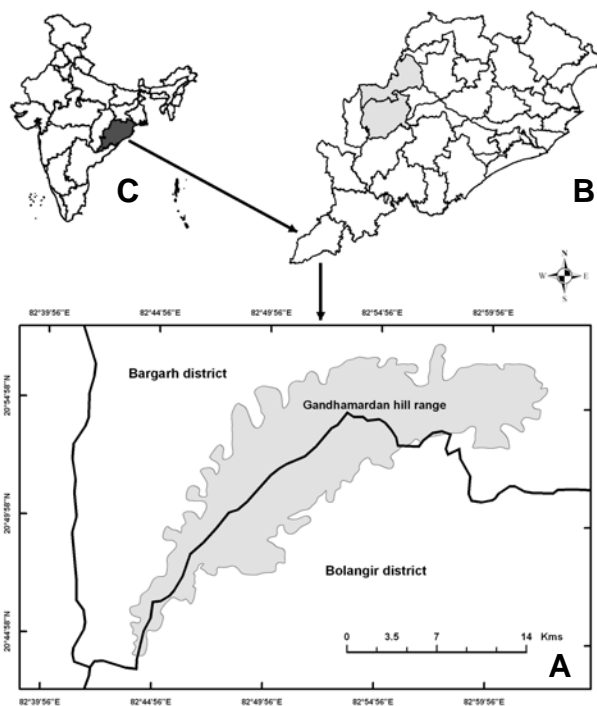


Fig. 1. Map of the Gandhamardan hill range (A), the study area, in Orissa (B), India (C).

area enjoys tropical monsoon climate. The mean annual rainfall ranges between 1250 and 1400 mm. The rainfall in the hill region and temperate climate facilitate tropical deciduous forest with a good number of medicinal plant species. Normally the rain depends on north-east monsoon. The maximum temperature goes up to 37°C in summer (April-May) whereas the minimum falls to 12°C in winter (December-January). The humidity is relatively high. The rock formation is archaic metamorphic called 'Khondalite' to high-level laterite (Pandey and Chatterjee, 1984).

The present study was carried out during 2004-2006. Data on taxon distribution within the Gandhamardan hill range were collected mainly from two sources: field observations and collection of specimens, and literature, while only in a few cases data were assembled from the Herbarium of Regional Research Laboratory (RRL-B). The majority of field observations were carried out from 2004 to 2006 during multiple field trips throughout each growth season. Accordingly, information on habit, habitat, flowering, fruiting period, etc. was recorded. Collection of plant specimens was carried out in both dry and wet seasons to know more information on habitat. The specimens collected were deposited in herbarium of RRL-B. The identification of specimens was carried out by consulting relevant literature (Patro, 1993; Saxena and Brahmam, 1995; Misra and Das, 1998, 2004) and regional floras (Gamble and Fischer, 1915-35; Haines, 1921-25; Mooney, 1950; Saxena and Brahmam, 1996). Life-form categories were identified according to Raunkiaer's system of classification (Raunkier, 1934).

### **Results and Discussion**

*Floristic composition:* The floristic composition of the hill is remarkable in its diversity and luxuriance. Altogether, 912 vascular plant taxa pertaining to 142 families and 556 genera were collected. The dicotyledonous plants belonged to 106 families, 418 genera and 685 species, and the monocotyledonous plants to 21 families, 122 genera and 206 species. Pteridophytes were represented by 21 species belonging to 15 families and 16 genera. Analysis of flora shows a comparatively higher representation of herbaceous species (519) followed by 173 trees, 119 climbers and 101 shrubs.

In comparison with the Orissa flora (total area 155,707 sq km) consisting of 2727 species (Saxena and Brahmam, 1996), 33.4% of species were recorded in the present study area. The recorded genera of the Gandhamardan flora were 52.4% of the Orissa flora, whereas the families covered 62.3%. A total number of 776 indigenous wild species, 64 introduced wild species and 72 cultivated species were found in the area. The species to genera ratio was 2.6 in Orissa flora, whereas it was 1.6 in the present study. The ratio of genera and family in the Gandhamardan flora was 3.9, whereas the value of the Orissa flora was 4.7. This indicates higher taxonomic diversity of the study area. Pielou (1975) and Magurran (1988) pointed out that, in intuitive terms, hierarchical (taxonomic) diversity will be higher in an area in which the species are divided amongst many genera as opposed to one in which most species belong to the same genus, and still higher as these genera are divided amongst many families as opposed to a few.

A comparison of ten dominant families in the Gandhamardan flora with those of the floras of Sambalpur (Panda and Das, 2004), Bihar and Orissa (Haines, 1921-25) and British India (Hooker, 1872-97) shows a close resemblance among each other (Table 1). Here Caesalpiniaceae (Caesalpinioideae), Papilionaceae (Fabaoideae) and Mimosaceae (Mimosoideae) are treated as subfamilies under Leguminosae. The relative position of

Leguminosae and Gramineae (Poaceae) are almost same in all the works. Scrophulariaceae, Apocynaceae and Malvaceae of the present work do not comply with the first ten families of the Flora of British India (Hooker, 1872-97) where Orchidaceae and Utricaceae are occupying the first and the last positions. Nine dominant families of the present work, except Leguminosae, are phylogenetically advanced and except Euphorbiaceae, all are herb-dominating. The prevalence of microclimatic conditions provided suitable habitats for herb-dominating flora. Euphorbiaceae was represented in this flora with 45 species of which 26 are trees and shrubs. They are mostly deciduous and majority of them contain latex. Leguminosae is one evenly distributed family with trees, shrubs, annual and perennial herbs, climbers and lianas. Most of the families represented in this flora are mainly tropical in distribution. In addition to this, a few temperate families such as Caryophyllaceae, Melastomataceae, Ranunculaceae and Violaceae were also found.

**Table 1. Comparison of ten dominant angiospermic families in the Gandhamardan flora from the present study with the floras of Sambalpur, Bihar and Orissa, and that of British India.**

Gandhamardan Flora (present study)	Sambalpur Flora (Panda and Das, 2004)	Bihar and Orissa (Haines, 1921-1925)	British India (Hooker, 1872-1897)
Leguminosae	Leguminosae	Leguminosae	Orchidaceae
Gramineae	Gramineae	Gramineae	Leguminosae
Euphorbiaceae	Euphorbiaceae	Cyperaceae	Gramineae
Rubiaceae	Compositae	Compositae	Rubiaceae
Compositae	Cyperaceae	Euphorbiaceae	Euphorbiaceae
Cyperaceae	Acanthaceae	Acanthaceae	Acanthaceae
Acanthaceae	Rubiaceae	Orchidaceae	Compositae
Scrophulariaceae	Scrophulariaceae	Rubiaceae	Cyperaceae
Apocynaceae	Labiatae	Labiatae	Labiatae
Malvaceae	Verbenaceae	Scrophulariaceae	Utricaceae

Exactly 50% of the recorded taxa belonged to only 13 species-rich families. The largest families in terms of number of species were Poaceae (90), Papilionaceae (68), Euphorbiaceae (45), Rubiaceae (41), Asteraceae (36), Cyperaceae (35), Acanthaceae (30), Caesalpiniaceae (20), Scrophulariaceae and Apocynaceae (each with 19 species). A total of 15 species of orchids belonging to 10 genera were also recorded. At genus level, *Ficus* showed the maximum diversity with 14 species. This was followed by *Cyperus* (11), *Cassia* (9), *Blumea* (8), *Bauhinia*, *Grewia*, *Hedyotis*, *Indigofera* (each with 7 species), *Acacia* and *Alysicarpus* (each with 6 species). Analysis of flora shows that most of the genera (388) are represented by single species and a very few genera are represented by more number of species. *Asparagus gonocladus* Baker, *Corchorus trilocularis* L., *Enicostema axillare* (Lam.) A. Raynal and *Triumfetta rotundifolia* Lam. were recorded new to the Flora of Orissa. *Erythrina resupinata* Roxb., *Heterostemma*

*tanjorensis* Wight & Arn. and *Tylophora fasciculata* Buch-Ham. ex Wight & Arn. are the unique species found in the study area, which are not sighted elsewhere in Orissa. There were 64 invasive exotic species also found, which will be serious threat to the forest ecosystem in the future. Important among them are *Ageratum conyzoides* L., *Chromolaena odorata* (L.) R. King & H. Robins., *Crotalaria pallida* Ait., *Hyptis suaveolens* (L.) Poit., *Lantana camara* L., *Mimosa pudica* L., *Parthenium hysterophorus* L. and *Triumfetta rhomboidea* Jacq.

The upper storey of the vegetation was covered by tall trees with epiphytic growth of lichens, bryophytes, ferns and orchids. It was interesting to note that *Shorea robusta* Gaertn. f., a common species in other parts of Orissa, showed sporadic distribution in the study area. Some of the shrubs e.g., *Ardisia solanacea* Roxb., *Flemingia macrophylla* (Willd.) Prain ex Merr., *Indigofera cassioides* Rottl. ex DC., *Leea asiatica* (L.) Ridsdale and *Morinda citrifolia* L., were found to grow in dense and interior forests. The bamboo species *Dendrocalamus strictus* (Roxb.) Nees. also occupied considerable part of the area. Herbs were mostly distributed all over the hill range, which includes open and dense forests, along the streams, top of the hills with grasses and forest road sides. A good number of lianas and woody climbers were present in the hill range, such as *Bauhinia vahli* Wight & Arn., *Calycopteris floribunda* Lam., *Combretum albidum* G. Don., *Cryptolepis buchmanii* Roem. & Schult., *Entada pursaetha* Spreng., *Hemidesmus indicus* (L.) R. Br., *Smilax zeylanica* L., *Toddalia asiatica* (L.) Lam., and *Ventilago madraspatana* Gaertn. Epiphytes were less in number. *Vanda testacea* (Lindl.) Reichb. f. and *V. tessellata* (Roxb.) Hook. ex G. Don. were two common epiphytic orchids found on branches of most tall trees. Four root parasites (*Aeginetia indica* L., *Melasma thompsonii* (Hook. f.) Wettst., *Sopubia delphinifolia* (L.) G. Don. and *Striga angustifolia* (D. Don) Saldanha) and two stem parasites (*Dendrophthoe falcata* (L. f.) Etting and *Viscum articulatum* Burm. f.) were also recorded from the study area. The extensive flat plateau on the top of the hills running through the whole length of the Gandhamardan range presented a grassland formation with luxuriant growth of various grass species attaining 2-3 m in height. The grassland comprises of *Arthraxon lancifolius* (Trin.) Hochst., *Capillipedium assimile* (Steud.) A. Camus., *Cymbopogon martini* (Roxb.) Wats., *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult. and interspersed with stunted growth of *Lagerstroemia parviflora* Roxb., *Phyllanthus emblica* L., *Pimpinella heyneana* (Wall. ex DC.) Kurz. and *Woodfordia fruticosa* L. Kurz.. Weeds such as *Borreria stricta* Roth ex Roem. & Schult., *Cleome monophylla* L. and *Mollugo pentaphylla* L. were common. *Celosia argentea* L. (introduced) is a weed of great nuisance in the abandoned fields near Borasambar, Paikmal and Harishankar.

*Life-form analysis:* The life-form spectrum in the present study showed predominance of phanerophytes (349 spp., 38.3% of the recorded species), followed by therophytes (298 spp., 32.7%), geophytes (128 spp., 14%), hemi-cryptophytes (119 spp.,

13%) and chamaephytes (18 spp., 2%). Majority of annuals were winter species or cool season species; some were hot-weather species, and a few were non-seasonal species responding to rainfall at any time of the year (e.g., *Tribulus terrestris* L.). The dominance of shrubby species over the grasses when water is limited, as in this area, can be explained by their extensive root system, which is capable of utilizing water stored at different soil depths, whereas grasses utilize the transient water stored in the upper soil synchronic with precipitation pulses. Besides the spatial variations in the species composition of plant communities, the composition of life forms reflected the response of vegetation to variations in certain environmental factors. In this study, the dominance of phanerophytes followed by therophytes over the other life forms seemed to be a response to the prevailing tropical moist and humid climate and biotic interference. The phanerophytes included trees, large woody shrubs, perennial herbs and woody climbers. Therophytes (annuals) are drought evaders in the sense that the whole plant sheds during unfavourable conditions. Moreover, the high proportion of therophytes in this study was also attributed to human activities (Raunkier, 1934).

*Medicinal plant exploration:* Gandhamardan hill range is also known as 'Ayurvedic paradise' and treasure house for potential medicinal plant species not only for Orissa but also for India. More than 300 plant species were found in the area with medicinal properties. These are depleting rapidly because of unsustainable harvesting, lack of awareness, and unrestricted grazing by domestic animals from nearby villages (Panigrahi, 1963; Pattanaik and Reddy, 2007). Nonetheless, many people from far and wide come to this area to collect medicinal plants and share their knowledge on medicinal uses of these plants. Major medicinal plant species, such as *Asparagus racemosus* Willd., *Celastrus paniculata* Willd., *Chlorophytum arundinaceum* Baker, *Costus speciosus* (Koenig) Sm., *Curculigo orchioides* Gaertn., *Curcuma angustifolia* Roxb., *Gloriosa superba* L., *Gymnema sylvestre* (Retz.) R. Br. ex Schult., *Plumbago zeylanica* L., *Rubia cordifolia* L. and *Tinospora cordifolia* (Willd.) Hook.f. & Thoms., were harvested in bulk for preparation of medicines by the local people. Unsustainable collection of above medicinal plants has placed them in threatened and vulnerable categories in Conservation Assessment and Management Plan (CAMP) of Orissa.

*Conservation measures:* In the prevailing situation, conservation of plant resources is very important, as many of these plants, for example *Asparagus gonocladus* and *Enicostema littorale* Blume, have been reduced to a greater extent. Therefore, sustainable utilization of medicinal plants is an urgent demand of the hour. Sustainable wild collection with fair trade would help to conserve the natural resources of the Gandhamardan hill range. Piloting of farmer-based cultivation trials for a selected number of threatened and indigenous medicinal plant species on the edges of forests and in home gardens should be encouraged. The state Forest Department should initiate *in situ* as well as *ex situ* conservation practices by promoting nurseries, home garden and

plantation. The state government should promote Village Management Committee (VMC) and Conservation Area Management Committee (CAMC) to protect the forests from denudation. Community mobilization and creating awareness on sustainable harvesting of plant parts among the local people of the surrounding villages must be done at priority level. The local non-government organisations (NGOs) should promote participatory research in breeding and participatory knowledge management involving scientists, government officials and tribal families. The Forest and Environment Department should establish linkages with markets, so that the cultivation of medicinal plants becomes market-driven, with assured income security for tribal families. Unrestricted movement of pilgrims all around the adjoining forest areas near to the temple are causing loss of plant species. It is necessary to improve the socio-economic conditions of people living around the hills to minimize the anthropogenic activities in order to prevent depletion of natural resources of this sacred hill range.

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