



RESEARCH ARTICLE

Tree ferns of Pachmarhi Biosphere Reserve, Madhya Pradesh, India: Taxonomy, Ethnobotany and Conservation

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Abstract

Tree ferns of the genus *Cyathea* belonging to the family Cyatheaceae, has 12 species in India. In the present observation only two species viz *Cyathea gigantea* (Wall. ex Hook.) Holtt. and *Cyathea spinulosa* Wall. ex Hook. are naturally growing in the Pachmarhi Biosphere Reserve (MP). The local people collected their young shoots, leaves and pith for food and traditional medicine. The paper elucidates the current diversity, taxonomy, distribution, ecology and conservation status of the tree ferns in the Biosphere Reserve on the basis of revisionary study and field survey. The observation made would be helpful in monitoring and management of remaining population of the tree ferns in the Biosphere Reserve.

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INTRODUCTION

The Tree ferns family Cyatheaceae are well known for their beautiful huge foliage throughout the world. It is the second largest living fern group among the pteridophytes. They always attract researchers and naturalists because of their remarkable morphology, wide geographical distribution and pronounced local endemism. It consists of about 700 species worldwide distributed in tropical rain forest, subtropical and temperate regions and Montane to Alpine regions from the wet lowlands to mid elevations (Tryon and Gastony, 1975; Conant *et.al.*, 1996). However, some species are also belonging to high mountain areas in the tropics at elevations up to 3500m (Bystrikova, 2011). (Tryon, 1970; Kramer & Green, 1990; Large & Braggins, 2004; Smith *et.al.* 2008; Sharpe & Mehlreter, 2010; Kholia *et.al.*, 2013). Most of the species of Cyatheaceae are scaly, spore-bearing, caudex massive, erect, thick, unbranched and arborescent. They usually have huge leaves (to 5 m), bipinnate-tripinnatifid lamina, veins free to margin, mostly simple or forked. Sori indusiate or exindusiate, apparently at the apex or the surface of the vein. Spores tetrahedral, trilete, non-perinate, exine smooth or granulose.

In India the family is represented by three genera *Cyathea*, *Cibotium*, *Spheropteris* and 21 species distributed in Eastern Himalayas, North East India, Western Ghats, Andaman Nicobar and Central India (Dixit, 1998; Chandra, 2001; Fraser-Jerkins, 2008). Although the lots of efforts has been done on Indian Tree fern, but in the lack of proper herbarium specimens and literature only fragmentary work have been done on this fascinating group of plant. Scott (1874) recognized 8 species from Sikkim Himalayas. Clarke (1880) reported 9 species from Northern India. Beddome (1883) reported 11 species from different other parts of the India. Mehra & Bir (1964) reported 3 genera and 10 species from the Darjeeling and Sikkim Himalayas. In 1965 Holttum worked on Asian Tree ferns and reported 11 species including *Cyathea* from India, of which *Cyathea nilgirensis* (Holtt.) Tryon was described as new to science and the two species *Cyathea henryi* (Bak.) Copel and *Cyathea contaminans* (Wall. ex

Hook.) Copel were considered as of doubtful occurrence. Later on Rao & Jamir (1985) described *Cyathea holttumiana* Rao & Jamir from Nagaland. Three species have been explored from South India (Manickam & Irudayaraj, 1992). Dixit & Sinha, 2001 reported two species from Andaman Nicobar Islands. Eight species were reported from North East India (Ghosh *et al.*, 2004). Dixit and Tripathi (1984) described *Cyathea balakrishnanii* Dixit & Tripathi as new to Science from Pachmarhi Biosphere Reserve (Central India). Tiwari (1964) and Vasudeva & Bir, (1993) mentioned the occurrence of 4 species of tree ferns including *Cyathea nilgirensis* (Holtt.) Tryon from Pachmarhi hills. In the recent investigations by authors on the basis of field survey, critical examination of herbarium specimens and published relevant literature revealed that *Cyathea balakrishnanii* (Dixit *et* Triparthi) Dixit and *Cyathea nilgirensis* (Holtt.) Tryon were not found in the Pachmarhi Biosphere Reserve.

The Pachmarhi Biosphere Reserve (PBR), one of the 18 biosphere reserves of India. The Pachmarhi Biosphere Reserve (PBR) (Fig. 1.) is located at Longitude 22° 11' to 22° 56' N and Latitude 77° 47' to 78° 52' E and covers three civil districts of Hoshangabad, Betul and Chhindwara of the Madhya Pradesh state (Map xi) PBR was established on March 3, 1999 in the Satpura Range of Madhya Pradesh. The total area is 4987.38 sq. km. It envelops three wildlife conservation units (Map i) viz Bori Sanctuary (485.72 sq. km.), Satpura National Park (524.37 sq. km.), and Pachmarhi Sanctuary (417.78 sq. km.). Satpura National Park comprises the core zone and the remaining area of 4525.93 sq. km. surrounding the core zone serves as buffer zone. It belongs to the Gondwana sandstone series. Its topography varies from undulating to flat with numerous flat-topped hills (*pats*) and hill ranges cut by innumerable streams, streamlets (*nallah*) and waterfalls. The altitude ranges from 250 to 1350 m. The main two rivers are Tawa and Denwa. The vegetation is mixed and dominated by dry and moist deciduous Sal and Teak forests of Central and South India. Total area is often recognized as “Genetic Express Highway” linking two biological hot spots of the country viz. Eastern Himalayas and Western Ghats, also as confluence of northern and southern type of vegetation. A few patches of montane subtropical forest occur in the Biosphere Reserve. The extremely dense forest covers nearly 80% of the total land area. They are endowed with high floral medicinal and economic properties, serve as a source of income for the local tribal people. The tribes inhabiting the area are Gond, Mauria, Paria, Bhartara and Baiga.

The average rain fall is about 200-250 cm annually. The mean temperature varies from 10°C to 38°C with relative humidity ranging from 40% to 98%. June is the hottest month with a maximum temperature of 45°C. January is the coldest month with minimum temperature of 3°C. The variable altitude and climatic conditions coupled with heavy rainfall have resulted in formation of waterfalls, marshy places, nalas, shaded gorges and streams. These are the ideal sites for the luxuriant growth moisture loving species such as bryophytes, orchids, fungi, lichens, pteridophytes including tree ferns, which emphasises the rich plant diversity in the area.

Throughout the globe tree ferns are used for many socio-economic purposes like ornamental, horticultural uses, food and medicinal uses etc (Scott 1874, Dixit, 1974, 1975; May, 1978; Manickam, 1999; Dixit & Singh, 2004; Rout *et al.*, 2009; Chandra & Jenkins, 2008, Kholia, 2013; Singh & Singh, 2012; Singh *et. al.*, 2013), hence due to heavy demand in market their wild population is rapidly declining (Dixit and Singh, 2004; Chandra, 2008) and are in under great threat of extinction. Keeping the aforesaid facts in view, the present study was undertaken and paper focus on the current diversity, nomenclature, distribution, ecological notes and conservation status of the tree ferns on the basis of revisionary study and field survey in the study area. The traditional uses and economic potential of this fascinating group of plants are also discussed.

Materials and methods

The present study is based on the field survey and critical examination (2005-2014) of voucher specimens housed in Central National Herbarium, Howrah and other various Regional Centre of Botanical Survey of India, Allahabad (BSA), other Regional circles of the Botanical Survey of India, Indian Council of Forest Research and Education, Dehradun (ICERF) and National Botanical Research Institute, Lucknow (NBRI). Field work (2005-2014) was carried out to observe the diversity, distribution, ecological notes and conservation status of tree ferns along the margin of various nalas and streams in different areas like Vanshi Vihar, Bharana, Sangam Vihar, Patharchatta, Sunder Pool, Panchham Dwar, Chanta Mani, Chhota mahadev, Handi Khoh, Vijay Prapat, Bee fall, Chauragarh, Duches's fall, Jalgali, Rajatprapat, Dhupgarh, Tridhara, Little fall, Silver Fall and Tamia in the Pachmarhi Biosphere Reserve. The conservation priorities and measures are suggested, based on distribution and population size. The traditional uses and economic potential of this fascinating group of plants are also discussed. The ethnobotanical data (local name, mode of preparation of medicines and their uses) were collected through questionnaire, interviews and discussions among village chiefs, traditional healers / *Vadhya* and local old men and women of ethnic groups. The voucher specimens in duplicate were deposited in the herbarium of the Regional Centre of Botanical Survey of

India, Allahabad (BSA), India and Herbarium, Department of Botany, Dr. Hari Singh Gaur University Sagar, MP, India.

Results

Diversity and current Taxonomic status of *Cyathea* taxa in Pachmarhi Biosphere Reserve, Madhya Pradesh

According to reversionary studies of Cyatheaceae of India by Dixit (1984, 1998), the genus *Cyathea* in India represented by 8 species out of which *Cyathea balakrishnanii* (Dixit *et* Triparthi) Dixit has been reported from Pachmarhi hills in Central India. Tiwari, 1964 and Vasudeva & Bir, 1993 have been mentioned the occurrence of 3 species *Cyathea gigantea* (Wall. *ex* Hook.) Holtt., *Cyathea spinulosa* Wall. *ex* Hook. and *Cyathea nilgirensis* (Holtt.) Tryon from Pachmarhi hills.

However, in the present analysis only two species *viz* *Cyathea gigantea* (Wall. *ex* Hook.) Holtt and *Cyathea spinulosa* Wall. *ex* Hoo.k are naturally growing in the Biosphere Reserve and presence of *Cyathea balakrishnanii* (Dixit *et* Triparthi) Dixit (Dixit, 1993) and *Cyathea nilgirensis* (Holtt.) Tryon are suspected. On the basis of field survey, critical examination of herbarium specimens and published relevant literature revealed that *Cyathea balakrishnanii* (Dixit *et* Triparthi) Dixit and *Cyathea nilgirensis* (Holtt.) Tryon were not found even in recent investigations by authors from the Pachmarhi Biosphere Reserve. *Cyathea balakrishnanii* (Dixit *et* Triparthi) Dixit, is the synonym of *Cyathea gigantea* (Wall. *ex* Hook.) Holtt and not endemic to Central India (Chandra *et. al.*, 2008). *Cyathea nilgirensis* (Holtt.) Tryon is endemic to south India and not growing in Pachmarhi hills, Madhya Pradesh at all. It is therefore concluded that the family Cyatheaceae is represented by only two species of *Cyathea* in Pachmarhi Biosphere Reserve. The current nomenclature, systematic account, habitat, ethnobotany, traditional and medicinal uses, ecology, distribution, phytogeography and conservation priorities are discussed below.

Systematic Account

CYATHEA Sm.

Cyathea Sm., Mem. Acad. Turin. 5: 416 (1793)

Type species: *Cyathea arborea* (L.) Sm., Mem. Acad. Turin. 5: 416 (1793)

Tree fern; trunk erect, tree like habit, caudex massive, scaly. Fronds spirally arranged; stipes smooth, spiny; lamina bipinnate or tripinnatifid, large, subcoriaceous or coriaceous. Sori indusiate, or exindusiate, dorsally on the veins. Spores tetrahedral, trilete.

Key to the species

1a Stipes shining stramineous-brown, 30-40 cm long, densely long spines throughout; pinnae, rachis and costae scaly on the lower surface Sori indusiate, near to costules, in single row either side of the costa.

C. spinulosa

2b Stipes dark black in colour, more than 100 cm long, less short spines usually at the base, pinnae, rachis and costae less hairy on the lower surface. Sori exindusiate, arranged in 'V' inverted shaped.

C. gigantea

- (1) *Cyathea gigantea* (Wall. *ex* Hook.) Holtt., Gard. Bull. Str. Sett. 8: 318 1935, Dixit, Census 93 1984 & Indian Fern J. 3: 45 1986; Vasudeva & Bir, Indian Fern J. 10: 117 1993; Chandra, Ferns India 92 2001.

Alsophila gigantea Wall. *ex* Hook., Sp. Fl. 1: 53 1844; Dixit, Indian Fern J. 15: 35 1998 Verma *et. al.* in Fl. Madhya Pradesh I: 74. 1993.

Alsophila helferiana Pr. Abh. Bohm. Ges. Wiss. Ser. 5: 341. 1848.

Alsophila glabra sensu Bedd., Ferns South India t. 60 1863 & Handbook 141883.

Alsophila umbrosa Wall. *ex* Ridl., J. Mal. Br. As. Soc. 4:6 1926.

Local Name: *Bina Kantewala Tree Fern* (Fig. 2.)

Tree fern, 200-300 cm tall; rhizome massive, erect, thick. Stipes up to 100 cm, dark blackish, rough, less short spines and less scaly at basal part, scales *ca* 10-12 x 10-20 mm, dark brown, stiff, shining with pale, fragile margins devoid of setae. Fronds pinnate, huge, tufted, compound. Lamina bipinnate-tripinnatifid, 40-72 cm, glabrous, thin, dark green, herbaceous; pinnae numerous pairs, 20-45 x 5-15 cm, deltoid, sessile, apex acuminate, base truncate; pinnules numerous, 8-10 x 15-20 cm, basal pinnules distinctly stalked, apex acuminate, base truncate, alternate, distinctly lobed up to 2/3rd towards frond costa, rarely from costule, margin serrate, rachis purplish, costa and costules scaly; veins free, 4-5 pairs, 10-24 pairs, simple, hairy, scaly. Sori exindusiate, arranged in 'V' inverted shaped, paraphyses dark brown, hair like. Spores trilete, hyaline to pale yellow, 26-34 x 22-30 μ m, exine smooth. Chromosome number: 2n=138 (Love *et al.*, 1977).

Ecology

Grow along the water channels in humid situations. Rare (700-1200m altitude).

Fertile

December-February.

Specimens examined

Shweta Singh PBR: Tamia 61089, 61139 (BSA), 04268, 04269 (IPU); Vanshi Vihar 61142 (BSA); Patharchatta 05238, 05239, Chhota mahadev 05245, 05246; Bee fall 55674 (BSA), 05247, 05248 (IPU); Little Fall 04255, 04256; Tridhara 55713 (BSA); Dutche's Fall 55756 (BSA). *Dixit* Tamia 32093, (BSA); *Panigrahi* Bee fall 4569 (BSA); *Dixit* PBR: Dhupgarh 41231A, 6630, 41175 (BSA).

Photograph examined

Wallich List No. 321 (type specimens, designated by R.E. Holttom on 1111962 (BSA); Sylhet, Nepalia 1829, *Wallich* List No. 321. (BSA).

Distribution

Bangladesh, Myanmar, China, Sri Lanka, Nepal, Thailand, Laos, Malaysia, Vietnam **INDIA:** Arunachal Pradesh, Sikkim, Assam, Meghalaya, Madhya Pradesh, Chhattishgarh, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala.

Central India: Bastar (Bailldilla Hills), Hoshangabad (Pachmarhi Hills); Chhindwara: (Tamia).

- (2) *Cyathea spinulosa* Wall. *ex* Hook., Sp. Fil. 1: 25 t. 12. C. 1844; Dixit, Census 94. 1984 & Indian Fern J. 3: 45 1986; Vasudeva & Bir, Indian Fern J. 10: 117 1993; Chandra, Ferns India 94. 2001; Bedd., Fern South. India t. 57. 1863 & Handbook 6. 1883.

Alsophila spinulosa (Wall. *ex* Hook.) Tryon, Contr. Gray Herb. 200: 1-53 1970; Verma *et. al.*, Fl. Madhya Pradesh I: 74. 1993; Dixit, Indian Fern J. 15: 37. 1998.

Alsophila decipiens Scott. *ex* Bedd., Ferns Brit. India. 311. 1869.

Hemitelia decipiens (Scott. *ex* Bedd.) Scott. Trans. Linn. Soc. 30: 33. t. 14. 1874.

Hemitelia beddomeii Clarke, Trans. Linn. Soc. London 2. Bot. 1: 429. 1880.

Cyathea taiwaniana Nakai, Bot. Mag. Tokyo 41. 68. 1927.

Local Name: *Kantewala Tree Fern* (Fig. 3.)

Tree fern; tall more than 10 m; trunk arborescent, erect, massive. Stipes 30-40 cm, closely spinose, scaly; spines 02-05 cm, pointed, sharp; scales *ca* 10-20 x 10-20 mm, linear-lanceolate, shining brown, margins narrow pale fragile. Fronds pinnate, huge, lamina bipinnate, 100-200 x 65-75 cm, glabrous, thin, dark green, subcoriaceous; pinnae numerous pairs, 38-45 x 10-15 cm, alternate, short petiolate, lanceolate, apex acuminate, base truncate or subtruncate, lowest pinnae the largest; pinnules numerous, 8-10 x 15-25 cm, alternate, petiolate, margin deeply lobed to the costa; lobes many, 08-1x 03-04 cm, falcate, oblong, narrow, acute, margins crenate, serrate, rachis tremendous brown, costae and costules scaly; veins free, 10-24 pairs, simple forked, pinnate, hairy, scaly. Sori indusiate, near to costules, in single row either side of the costa, large, rounded; indusia light brown, globose. Spores trilete, pale yellow, 32-42 x 24-30 μ m, tetrahedral to globose, exine smooth.

Chromosome number: $n=69$ (Love *et al.*, 1977; Khullar, 1994).

Ecology

Common tree fern, grow along the water channels in hilly regions (950-1200m altitude).

Fertile

September-December.

Specimens examined

Shweta Singh, PBR: Vijay Prapat 61086, 61082 (BSA); Bee Fall 61135, 55673 (BSA); Jalgali 55712 (BSA); Dutche's Fall, 55789 (BSA); 03319, 03321, 03312 (IPU); Vanshi Vihar 0223 (BSA); Bharana 0228, 0229 (BSA); Tridhara 03336, 03337 (IPU); Sangam Vihar 0334, 0335 (BSA); Handi Khoh 03311, 03313 (IPU); Chauragarh 03317 (BSA); Dixit Dhupgarh 41197 (BSA); Tridhara, 41298 (BSA), *Pant*, Tridhara 27173 (BSA).

Photograph examined

Wallich List No. 178. (BSA).

Distribution

Bhutan, Myanmar, Cambodia, China, Japan, Malasiya, Nepal, Taiwan, Thailand, Tibet, Indonesia.

INDIA- Uttaranchal, Arunachal Pradesh, Sikkim, West Bengal, Assam, Meghalaya, Madhya Pradesh, Chhattishgarh, Karnataka, Tamil Nadu, Andaman & Nicobar.

Central India: Bastar (Bailladilla Hills), Hoshangabad (Pachmarhi Hills); Chhindwara: (Tamia).

Ethnobotany of Tree Ferns

The ethnobotanical data (local name, mode of preparation, medicinal uses) were collected through questionnaire, interviews and discussions among village chiefs, traditional healers/*Vadhya* and local old men/women of various ethnic groups who have the knowledge of the utilization of plants as herbal medicine in their local language Surveys were conducted in different villages of near and around the Pachmarhi Biosphere Reserve (Fig. 4.). The data were collected according to the methodology suggested by Jain (1964, 1965 & 1991).

(a) Ethnomedicinal Use

- (1) *Cyathea spinulosa*: Dried powder of fronds and stem used orally in Rheumatic Arthritis (Tangieng, *et al*, 2011). Fresh soft pith and root are edible and used in the preparation of local drinks are locally applied on wounds leaves are locally applied on wounds (Manickam, 1999; Dixit & Singh; 2004; Singh *et al*, 2005).
- (2) *Cyathea gigantea*: 10g fresh rhizome mixed with 1g black pepper seed (*Piper nigrum*) powder, used orally with cow milk twice a day for a week in empty stomach against white discharge in women (Singh & Singh, 2012; Singh *et al*, 2013). Extract of grinded rhizome and young petiole is given in snake bite Fresh soft pith is edible (Shankar & Khare 1992; Dixit & Singh; 2004; Singh *et al*, 2005). Paste of fresh rhizome is used locally on the cuts and boils. It has antitumor, antiviral and hepatoprotective activity (Kiran, *et al*, 2012).

(b) Veterinary Uses

Soft fresh fronds, stipes and stems used as fodder for good health of cattle. They applied fresh paste of fronds and stipes on the body of the cattle for the growth of healthy hairs and skin.

(c) Uses in traditional rituals

In Central India especially in Pachmarhi Tree ferns are integral parts of all religious ceremonies of local tribal communities. They have with strong belief that their survival is dependent on the survival of these ferns. Tree fern are considered as a sign of good luck. The patients suffering from headache, severe fever, hypertension and other nervous system related troubles are suggested by the traditional healers to pass some time near to these species without harming it has been observed during the recent surveys that the healers are staying in small huts near the wild population of *Cyathea* species and arrange the windows opening towards these plants. They keep small piece of dried rhizome under the pillow or bed sheet of the babies and new born child suffering from fever, cold, cough and stomachache. They belief tree ferns are having anti-ageing properties. They also used it in popular herbal combinations in treatment of different types of cancer. The general thinking is to protect them from evil spirits. Many wild animals like wild pigs, dogs and snakes kept distance with these species. These plants are extracted widely along with the rhizome, resulting rarity of the species from the wild by local traders and greedy collectors (Dixit & Singh, 2004). To stop over exploitation, the tribal people and traditional healers are not ready to disclose detected and undetected localities as well as the folk uses of tree ferns the at any cost.

(d) Other uses

Trunk of tree fern is most suitable for growing orchids (Dixit, 1986). They are used in making handicraft material in Mexico Trunks have been used in construction of building and fences (Eleutério & Pérez-Salicrup, 2006). Fronds are used as fodder as well as thatching the huts (Upteri, 2009).

Its ethnobotanical knowledge if recognized, valued, implemented and documented properly can conserve the biodiversity of tree ferns of the area and help the environment and society in a holistic way.

Phytogeography

Tree ferns mostly subtropical forest fern of eastern Himalayan region usually grow along the stream side, small streamlet (*nallah*), in valley forests or in the forest margins at altitude 500-2000m. It is very rare in western Himalaya only a single species *Cyathea spinulosa* has been recorded from Uttarakhand (Naithani, 1969; Khullar, 1994, Pande & Pande, 2003) and from Jammu (Kapur, 1985). *Cyathea spinulosa* has been reported from subtropical forest of southern, central and northern India (Khare, *et. al.* 2005). *Cyathea gigantea* has been reported from Northeastern and Peninsular India (Jain & Sastry, 1980; Baishya & Rao, 1982; Jamir & Rao, 1988; Manickam & Irudayaraj, 1992, 2003; Jamir & Pandey, 2003).

Central India is often recognized as confluence of northern and southern type of vegetation. In Pachmarhi Biosphere Reserve the total Eighteen important reference points (localities) *viz*, Vanshi Vihar, Bharana, Sangam Vihar, Patharchatta, Sunder Pool, Panchham Dwar, Chanta Mani, Chhota mahadev, Handi Khoh, Vijay Prapat, Bee fall, Chauragarh, Duches's fall, Jalgali, Rajatprapat, Dhupgarh, Tridhara, Little fall, Silver Fall and Tamia have been surveyed. *Cyathea gigantea* may grow at low altitude of 600-900m as well as high altitude (1000-1200m), but the *Cyathea spinulosa* was not reported below 950m. It is interesting to observe that number of individuals of *Cyathea gigantea* was higher and most abundant with high population density (200 plants/100 m²), whereas *Cyathea spinulosa* was with very low density (30 plants/100 m²) at most of the population site like Patharchatta, Chhota mahadev, Vijay Prapat, Bee fall, Little Fall and Tamia elevation below 950m. The number of individuals and population density (100-150 plants/100 m²) of *Cyathea spinulosa* was higher whereas *Cyathea gigantea* was with low density (75- plants/100 m²) at most of the high elevation (1000-1200m) localities like served like Vanshi Vihar, Bharana, Sangam Vihar, Handi Khoh, Duches's fall, Jalgali, Chauragarh, Dhupgarh and Silver fall. The altitudinal distribution of these tree ferns indicates that *Cyathea gigantea* is probably more adapted to subtropical montane climate in comparison to *Cyathea spinulosa*.

The distribution of both the two species of *Cyathea* in Central India is mainly concentrated on the banks of streams and *nallahs* in deep secondary forests where the elevation ranges from 600-1200m. It has been observed that

despite the continuity of stream network only few specific pockets have been occupied by Tree Ferns. Their restricted distribution and site specificity is may be due to presence of continuous source of water and undisturbed constant damp environment.

Conservation priorities and future research for Tree ferns

In the face of the environmental crisis and global climate change and human interference, the concentrations of Cyatheales in this region sound the alarm on their conservation priorities (Santiago *et al*, 2011). Limited research and unavailability of literature is a main barrier to conservation and management of these species. For the conservation of this fascinating group of plants both species *Cyathea gigantea* and *Cyathea spinulosa* are listed under IUCN Red data book, negative plants list and Appendix II of CITES as high conservation priority plants (CITES, 2014, Kholia *et al*, 2013). Dedicated research work and management plan are require for identifying the level of threat to Tree ferns and categorizing them according to red listing criteria. Such information will help in preparing conservation and management plan for the protection of Tree fern in the area. *In-situ* conservation in natural forests should be the priority for the tree fern species growing in protected areas. However the preliminary observation on distribution, ecology, phytogeography, population sizes shows that further research and monitoring of existing population are required for effective conservation (Dixit & Singh, 2004). Recent exploration reveals the previously undetected and new populations sites of tree fern in the area. Extensive field survey of all wet zone area should be in high priority in order to explore further availability of different, new species and population sizes in protected area.

Collection of germplasm, propagation and the establishment at botanical gardens (*ex-situ* conservation measure) is urgently required. The trunk of both the species are collected from the wild and sold as growth media for Orchids cultivation. The local people collected their young shoots, leaves and pith for food and traditional medicine. It is therefore important to study and regulate their sustainable utilization with minimum disturbance to natural populations. More researches are required on its advance techniques for cultivation methods, spore germination and subsequently development of sporophytes on artificial media to facilitate cultivation (Ranil *et al*, 2011). Awareness programs for local tribal are required to conserve these plants through cultivation, social and religious (sacred) ceremonies, cults and belief.

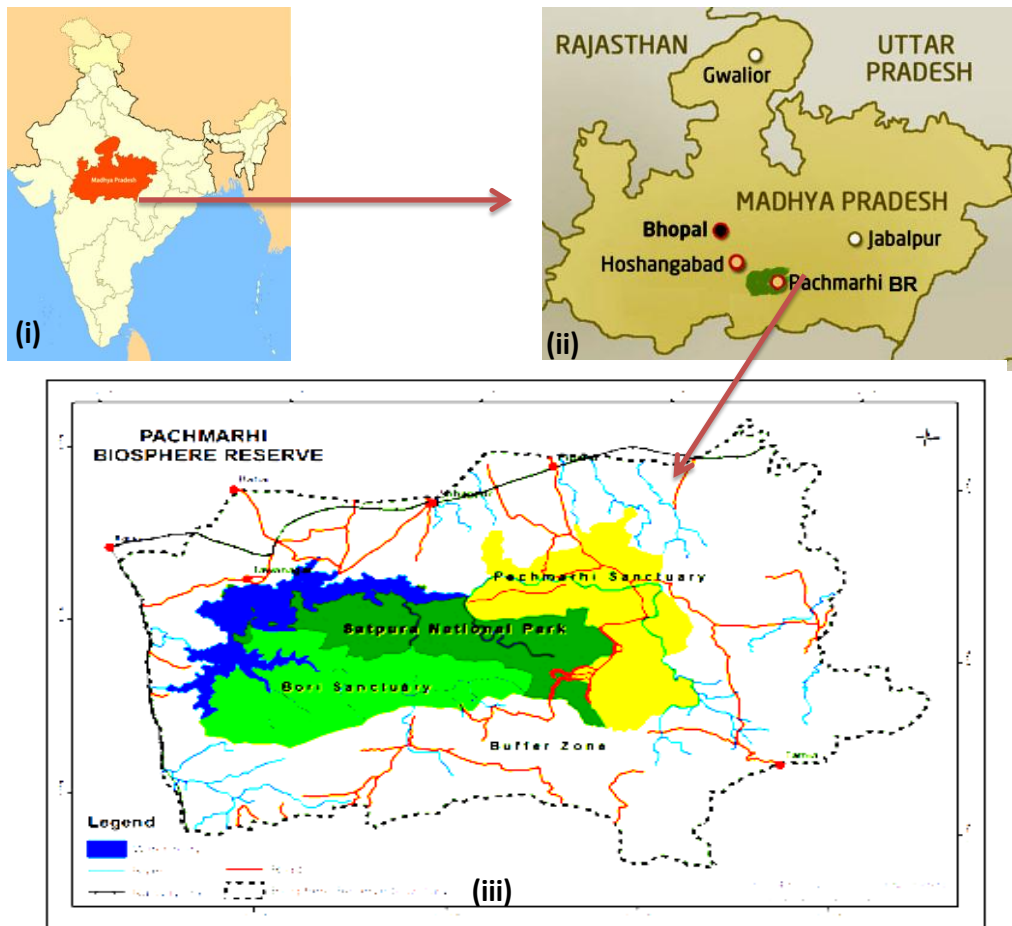


Fig. 1. Location map of Pachmarhi Biosphere Reserve in India



Fig. 2. *Cyathea gigantea* (a) Pinnae of young plant, (b) Sori arrangement, (c) Stipe base showing hairs and spines, (d, e) Top of trunk showing crozier, (f) Habit



Fig. 3. *Cyathea spinulosa* (a) Pinnae of young plant, (b) Sori arrangement, (c) Spines, (d) Top of trunk showing crozier, (e) Habit



Fig. 4. (a) Crown, (b) Herbal medicine and Rhizome sold in the local market, (c) Diversity of Tree fern in forest, (d) Destroyed bark and rhizome

Discussion

This paper gives a broad outlook about the Tree fern and focusing on current diversity, taxonomy, ecology, distribution and conservation status of all the species of the *Cyathea* on the basis of revisionary study and field survey in the study area. On the basis of critical field survey, study of herbarium specimens and published relevant literature revealed the presence of only two species *Cyathea gigantea* and *Cyathea spinulosa*.

Cyathea balakrishnanii (Dixit et Triparthi) Dixit, and *Cyathea nilgirensis* (Holtt.) Tryon are not found even in recent investigations by authors from the Pachmarhi Biosphere Reserve. It is therefore concluded that the family Cyatheaceae is represented by only two species of *Cyathea* in Pachmarhi Biosphere Reserve. Both the two taxa of Tree-ferns are restricted to small area in the Pachmarhi forest. They form a vital component of the ecosystem and can be taken as good indicators of the extent of problems like deforestation and habitat destruction. Effective measures need to be taken for developing Tree ferns sample-reserves which are strictly protected against the problems of grazing, disturbance and deforestation which are otherwise affecting the existing reserves. Botanical explorations should be necessary in the under-explored botanically rich areas for assessment of population, existing diversity and ecological characteristics of Tree ferns. Taxonomic reinvestigations and revision should take place in order to avoid the confusions with new species and existing species. The survival of these species depends primarily on the effective *in-situ* conservation, monitoring and managing the natural calamities forest fire, landslides, heavy rainfall etc by forest officials of the state and Central Governments and finally *ex-situ* programmes for propagation

and re-establishment. Recent research indicates biological significance and diversity of *Cyathea* species and the urgent necessity of further exploration of surviving wet zone forest.

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