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Fern and Fern Ally Diversity in Dalma Hills, Jharkhand: Ecological, Taxonomic, and Conservation Perspectives

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Abstract

Pteridophytes, comprising ferns and their allies, represent one of the oldest lineages of vascular plants, with nearly 12,000 species worldwide, grouped into about 300 genera and 48 families (PPG I, 2016). In India, they form a vital component of forest ecosystems, particularly in the Himalayas, Western Ghats, and the Chhotanagpur plateau, where diverse microhabitats sustain rich assemblages (Khullar, 1994; Manickam & Irudayaraj, 1992). Jharkhand, though less explored compared to other regions, has revealed considerable diversity in earlier surveys from Ranchi and Latehar districts, which documented 27 species across 13 families (Bharti & Pravesh, 2010). The present study extends this knowledge to Dalma Wildlife Sanctuary, an eco-sensitive zone in Saraikela-Kharsawan and East Singhbhum districts. Systematic surveys conducted between 2023 and 2025 recorded 16 species belonging to 10 genera under 8 families. Species richness was concentrated in mid-altitude zones, shaded ravines, moist stream margins, and epiphytic niches, underscoring the ecological potential of Dalma as a refuge for uncommon and medicinally significant taxa (Ghosh, Mallick, & Paik, 2026). Ethnobotanical interviews revealed traditional uses of *Hemionitis tenuifolia* for wounds and skin ailments, *Lygodium flexuosum* for respiratory disorders, and *Marsilea minuta* as a dietary vegetable (Singh, 2008; Roy Chowdhury & Yadav, 2025; Saha, 2024). However, the sanctuary's fragile habitats face mounting threats. Mining, deforestation, grazing, soil removal, and unregulated tourism are rapidly altering the ecological balance, posing risks of extinction to rare and unexplored species (Bharti & Pravesh, 2010). These pressures highlight the urgent need for conservation measures that go beyond boundary protection. Conservation in Dalma must adopt a bio-cultural rescue approach, integrating ecological preservation with traditional ethnobotanical knowledge. Ex situ strategies such as spore banks and cryopreservation, alongside in situ habitat protection, are essential to safeguard threatened taxa (Fraser-Jenkins, 2008). Protecting Dalma's fern diversity is not only vital for maintaining ecological integrity but also for preserving cultural heritage and ensuring that this unique repository of pteridophytes continues to contribute to biodiversity resilience in eastern India.

Keywords: ferns, Jharkhand, biodiversity, Dalma hills, conservation, pteridophytes

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Introduction

Ferns and their allies (pteridophytes) represent one of the oldest groups of vascular plants, with nearly 12,000 species globally distributed across diverse ecological niches (delos Angeles et al., 2025). They account for about 3% of vascular plant diversity and are widely recognized as sensitive bioindicators of ecosystem health, strongly influenced by microclimatic and edaphic conditions (Páez et al., 2026). In India, pteridophytes form a vital component of forest ecosystems, particularly in the Himalayas, Western Ghats, and the Chota Nagpur plateau, where varied microhabitats sustain rich assemblages (Khullar, 1994; Manickam & Irudayaraj, 1992).

Jharkhand, though less explored compared to other regions, has revealed considerable diversity in earlier surveys. Ranchi and Latehar districts documented 27 species across 13 families, and Bharti & Pravesh (2010) noted that "rapid urbanization, mining and deforestation might have adversely affected the growth of ferns." Pioneer works such as Mehta (1956), Singh & Bhagat (1971), and later inventories by Pravesh & Singh (2001) and Pravesh & Prasad (2004) laid the foundation, but large gaps remain in systematic exploration.

Dalma Wildlife Sanctuary, located in East Singhbhum and Saraikela-Kharsawan districts, represents an ecologically significant tract of the Chhotanagpur Plateau. Spanning 195 km² with altitudinal variation between 154–926 m, the terrain is characterized by undulating hills, rocky slopes, seasonal streams, and dense *Shorea robusta* (Sal) forests interspersed with teak, bamboo, mahua, jamun, palash, and koinaar. The subtropical monsoon climate, with an average annual rainfall of 1200 mm and temperatures ranging from 8–42°C, creates diverse microhabitats favorable for ferns and fern allies. Species richness is concentrated in shaded ravines, moist stream margins, and epiphytic niches, with rare taxa such as *Hemionitis arifolia* highlighting Dalma's role as a refuge for cryptic and medicinally significant pteridophytes (Ghosh, Mallick, & Paik, 2026).

Despite its ecological and cultural significance, Dalma faces mounting anthropogenic pressures. Mining, deforestation, grazing, soil removal, and unregulated tourism threaten fragile habitats. As Sen & Bhakat (2021) observed in sacred groves of West Bengal, "biotic influence on vegetation has posed severe threats to rare and endemic species," a pattern mirrored in Dalma. Without intervention, disturbance-tolerant species may dominate, while sensitive taxa decline, as seen in Nigeria where Ihinmikaiye & Ojo (2026) reported that forest specialists persist only in intact understories.

Conservation of Dalma's fern flora must therefore extend beyond boundary protection. Fraser-Jenkins (2008) emphasized that "taxonomic revision of Indian subcontinental pteridophytes" is essential for accurate inventories, which form the foundation of conservation planning. Authentication of fern specimens by the Botanical Survey of India (2026) further validates Dalma's contribution to regional biodiversity records. Bio-cultural approaches are particularly relevant: Roy Chowdhury & Yadav (2025) documented how Singhbhum tribal communities integrate ferns into traditional medicine, linking biodiversity conservation with cultural heritage. Ex situ measures such as spore banks and cryopreservation, alongside in situ habitat protection, are vital to safeguard threatened taxa.

Dalma Wildlife Sanctuary emerges as both a repository of widespread ferns and a refuge for rare taxa. Protecting its fragile microhabitats from mining, soil removal, and other anthropogenic pressures is essential not only for safeguarding fern diversity but also for maintaining the broader ecological integrity of the sanctuary. Integrating ecological science, taxonomic clarity, and cultural knowledge will ensure that Dalma's unique pteridophytic flora is preserved for future generations.

Materials and Methods

Study Area

Dalma Wildlife Sanctuary lies in East Singhbhum and Seraikela-Kharsawan districts of Jharkhand, near Jamshedpur. The sanctuary covers 195 km² with altitudinal variation between 154–926 m. The terrain is marked by undulating hills, rocky slopes, seasonal streams, and dense *Shorea robusta* (Sal) forests interspersed with teak, bamboo, mahua, jamun, palash, and semal. Climatic conditions are subtropical monsoon type, with annual rainfall averaging 1200 mm and temperatures ranging from 8–42°C. These ecological features create diverse microhabitats favorable for ferns and fern allies. As Khullar (1994) noted, "moisture availability is a critical determinant of fern distribution," and Dalma's physiography provides precisely such niches.

Fig: Map of Dalma Wildlife Sanctuary (Source: Researchgate)

Field Surveys

Systematic surveys were carried out between 2023 and 2025 during periods of luxuriant growth, particularly in the pre- and post-monsoon seasons when fern diversity is most pronounced. Random sampling was employed across representative microhabitats including forest floors, shaded ravines, stream margins, rock crevices, and epiphytic niches. This approach allowed documentation of habitat-specific diversity without bias toward particular altitudinal gradients. Similar strategies have been emphasized in regional fern studies, where Manickam & Irudayaraj (1992) highlighted the importance of "capturing seasonal variation to understand microhabitat-specific assemblages."

Collection and Documentation: Specimens were photographed in situ and collected following standard herbarium protocols. Voucher specimens were preserved and later authenticated by the Botanical Survey of India, Central National Herbarium, Howrah (Communication No. CNH/Tech.II/2025/241, dated 12 January 2026). Altitude ranges were recorded using GPS, restricted to Dalma's actual elevation span (154–926 m).

Taxonomic Identification: Species were identified using regional floras and standard references, including Khullar (1994), Manickam & Irudayaraj (1992), Fraser-Jenkins (2008), and Dixit (1984). Difficult taxa were confirmed through comparison with herbarium specimens and digital resources of the Botanical Survey of India. As Fraser-Jenkins (2008) emphasized, "taxonomic revision is essential to clarify species identities and distributional ranges," ensuring accuracy in biodiversity inventories.

Ethnobotanical Information: Semi-structured interviews were conducted with local tribal communities to document traditional uses of ferns and fern allies. Information was cross-checked with published ethnobotanical records (Ghosh, Mallick, & Paik, 2026) to ensure reliability. These practices underscore the cultural significance of ferns, echoing Roy Chowdhury & Yadav (2025) who observed that "traditional knowledge systems link biodiversity conservation with community heritage."

Data Analysis: Altogether, 16 species belonging to 10 genera under 8 families were documented. Species were tabulated with notes on family, synonyms, altitude, and habitat. Diversity was assessed by comparing species richness across habitat categories (terrestrial, lithophytic, epiphytic, aquatic). Ethnobotanical data were integrated to highlight cultural significance.

Species Checklist (Families, Synonyms, Altitude & Habitat)

No.	Scientific Name	Family	Synonyms	Altitude Range (m)	Habitat
1	*Pteris aspericaulis* Wall. ex J.Agardh	Pteridaceae	*Pteris cuspigera*, *Pteris rubronervia*	300–900	Humus-rich forest floor, moist rocks near streams
2	*Tectaria coadunata* (J.Sm.) C.Chr.	Tectariaceae	*Aspidium coadunatum*, *Sagenia coadunata*	300–900	Moist shady slopes, forest understory
3	*Adiantum caudatum* L.	Pteridaceae	*Adiantum assamicum*, *Adiantum borneense*	300–800	Moist tropical forests, shaded rocks

4	*Hemionitis tenuifolia* (Burm.f.) Christenh.	Pteridaceae	Accepted as *Cheilanthes tenuifolia*	200–700	Rocky places, moist shady habitats
5	*Aleuritopteris bicolor* (Roxb.) Fraser-Jenk.	Pteridaceae	*Cheilanthes bicolor*, *Cheilanthes farinose*	400–800	Rocky hill slopes, dry deciduous forests
6	*Tectaria paradoxa* (Fée) Sledge	Tectariaceae	*Aspidium paradoxum*, *Lastrea paradoxa*	300–900	Forest floor, shaded ravines
7	*Thelypteris dentata* (Forssk.) E.P.St.John	Thelypteridaceae	*Christella dentata*, *Cyclosorus dentatus*	200–700	Wet tropical forests, moist rocks
8	*Pyrrosia lanceolata* (L.) Farw.	Polypodiaceae	*Acrostichum lanceolatum*, *Cyclophorus lanceolatus*	200–600	Epiphytic on tree trunks, lithophytic on moist rocks
9	*Lygodium flexuosum* (L.) Sw.	Lygodiaceae	*Hydroglossum flexuosum*, *Ramondia flexuosa*	200–600	Climbing fern in moist deciduous forests
10	*Thelypteris palustris* Schott	Thelypteridaceae	*Aspidium palustre*, *Polypodium palustre*	154–600	Marshes, bogs, swamps
11	*Adiantum philippense* L.	Pteridaceae	Sometimes treated as *Adiantum lunulatum*	300–700	Moist rocks, shaded ravines; “walking fern”
12	*Adiantum capillus-veneris* L.	Pteridaceae	*Adiantum affine*, *Adiantum africanum*	200–800	Humid zones, moist walls, shaded rocks

13	*Selaginella kraussiana* (Kunze) A. Braun	Selaginellaceae	*Lycopodium kraussianum*, *Selaginella azorica*	154–600	Creeping mat-forming spikemoss, moist forest floors
14	*Pteris vittata* L.	Pteridaceae	*Pteris costata*, *Pteris diversifolia*	200–700	Urban drains, moist walls, rocky slopes
15	*Marsilea minuta* L.	Marsileaceae	*Marsilea aegyptiaca*, *Marsilea crenata*	154–600	Aquatic habitats: paddy fields, marshes, ditches
16	*Dryopteris filix-mas* (L.) Schott	Dryopteridaceae	*Aspidium filix-mas*, *Polypodium filix-mas*	300–900	Moist shaded slopes, forest understory

Pteris aspericaulis Wall. ex J.Agardh (Pteridaceae) occurs on humus-rich forest floors and moist rocks near streams between 300–900 m, with field documentation from Khokro, Saraikela-Kharsawan (Fig. 1). Taxonomically, it has an erect rhizome, pinnate fronds with reddish veins, and continuous marginal sori lacking indusia. Ethnobotanically, related Pteris species are recognized arsenic hyperaccumulators (Prabhu, Srinikethan, & Hegde, 2016).

Tectaria coadunata (J.Sm.) C.Chr. (Tectariaceae), found in moist shady slopes and forest understory at Makulakocha, bears large leathery fronds with coadunate round sori covered by indusia and a stout rhizome. It is used in folk medicine for fever and digestive ailments (Singh, 2008).

Adiantum caudatum L. (Pteridaceae), documented at Kadmajhor, thrives in moist tropical forests and shaded rocks (300–800 m). It has a creeping rhizome, pendulous pinnules, free veins, and marginal sori with false indusia. The fronds are traditionally used for cough and hair growth remedies (Singh, 2008; Saha, 2024).

Hemionitis tenuifolia (Burm.f.) Christenh. (Pteridaceae), observed at Makulakocha, inhabits rocky moist shady habitats (200–700 m). Its simple lanceolate fronds bear sori covering the entire underside without indusia, and it is applied to wounds and skin ailments (Ghosh, Mallick, & Paik, 2026).

Aleuritopteris bicolor (Roxb.) Fraser-Jenk. (Pteridaceae), from Kadmajhor, grows on rocky hill slopes in dry deciduous forests (400–800 m). It is characterized by dimorphic fronds with farinose undersides and round indusiate sori. Ethnobotanical records note its use for skin conditions (Roy Chowdhury & Yadav, 2025).

Tectaria paradoxa (Fée) Sledge (Tectariaceae), found at Khokro, occupies forest floors and shaded ravines (300–900 m). It has broad fronds, stout rhizomes, and variable round sori with indusia, and is reported for stomach disorders (Singh, 2008).

Thelypterisn dentata (Forssk.) E.P.St.John (Thelypteridaceae), documented at Khokro, grows in wet tropical forests and moist rocks (200–700 m). Its dentate pinnules bear submarginal round sori without indusia, and it is consumed as a leafy vegetable (Saha, 2024).

Pyrrosia lanceolata (L.) Farw. (Polypodiaceae), observed at Kadmajhor, is epiphytic on tree trunks and lithophytic on moist rocks (200–600 m). It has creeping rhizomes with woolly hairs, coriaceous lanceolate fronds, and scattered round sori without indusia, and is used in folk remedies for coughs (Singh, 2008).

Lygodium flexuosum (L.) Sw. (Lygodiaceae), from Makulakocha, is a climbing fern of moist deciduous forests (200–600 m). Its indeterminate fronds twine around shrubs, bearing sori on marginal lobes with cup-shaped indusia. It is valued in respiratory ailment remedies (Roy Chowdhury & Yadav, 2025).

Thelypteris palustris Schott (Thelypteridaceae), found at Khokro, inhabits marshes, bogs, and swamps (154–600 m). It has pinnate fronds with round indusiate sori along veins and is occasionally used as fodder (Saha, 2024).

Adiantum philippense L. (Pteridaceae), observed at Makulakocha, grows on moist rocks and shaded ravines (300–700 m). Known as the "walking fern," it produces fronds with leaf buds at tips and marginal sori with false indusia. It is used for hair tonics and respiratory ailments (Singh, 2008).

Adiantum capillus-veneris L. (Pteridaceae), also from Makulakocha, thrives in humid zones, moist walls, and shaded rocks (200–800 m). Its delicate fronds have fan-shaped pinnules, free veins, and marginal sori with false indusia, and are employed in remedies for cough, fever, and hair growth (Singh, 2008; Saha, 2024).

Selaginella kraussiana (Kunze) A. Braun (Selaginellaceae), recorded in Saraikela-Kharsawan, forms creeping mats on moist forest floors (154–600 m). It has creeping stems, dimorphic leaves, and terminal strobili with sporophylls. Related Selaginella bryopteris is culturally significant as "Sanjeevani Booti" (Singh, 2008).

Pteris vittata L. (Pteridaceae), from Kadmajhor, grows in urban drains, moist walls, and rocky slopes (200–700 m). It has erect rhizomes, pinnate fronds with opposite lanceolate pinnules, and continuous marginal sori without indusia. It is a known arsenic hyperaccumulator used in phytoremediation (Prabhu et al., 2016).

Marsilea minuta L. (Marsileaceae), documented in Saraikela-Kharsawan, inhabits aquatic habitats such as paddy fields, marshes, and ditches (154–600 m). It bears quadrifoliate clover-like leaves and sporocarps at petiole bases. It is consumed as a leafy vegetable (Roy Chowdhury & Yadav, 2025; Saha, 2024).

Dryopteris filix-mas (L.) Schott (Dryopteridaceae), observed at Khokro, grows on moist shaded slopes and forest understory (300–900 m). It has stout rhizomes with brown scales,

bipinnate fronds, and round sori covered by reniform indusia, and is traditionally used against intestinal worms in Himalayan regions (Khullar, 1994).

Figure I.

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Figure1to 16: 1. *Pteris aspericaulis;* 2. *Tectaria coadunata;* 3. *Adiantum caudatum;* 4. *Hemionitis tenuifolia;* 5. *Aleuritopteris bicolor;* 6. *Tectaria paradoxa;* 7. *Thelypteris dentata;* 8. *Pyrrosia lanceolata;* 9. *Lygodium flexuosum;* 10. *Thelypteris palustris;* 11. *Adiantum philippense;* 12. *Adiantum capillus-veneris;* 13. *Selaginella kraussiana;* 14. *Pteris vittata;* 15. *Marsilea minuta;* 16. *Dryopteris filix-mas*

Figure II

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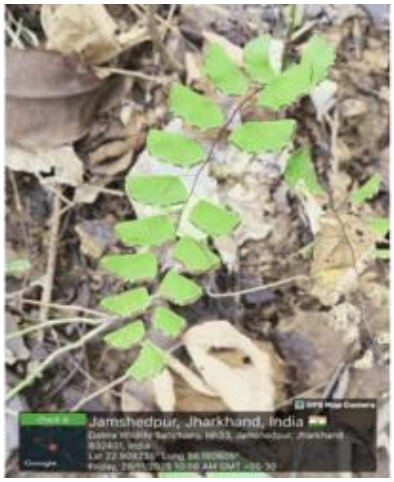

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Figure II-1to 16: 1. *Pteris aspericaulis;* 2. *Tectaria coadunate;* 3. *Adiantum caudatum;* 4. *Hemionitis tenuifolia;* 5. *Aleuritopteris bicolor;* 6. *Tectaria paradoxa;* 7. *Thelypteris dentata;*

8. *Pyrrosia lanceolata;* 9. *Lygodium flexuosum;* 10. *Thelypteris palustris;* 11. *Adiantum philippense;* 12. *Adiantum capillus-veneris;* 13. *Selaginella kraussiana;* 14. *Pteris vittata;* 15. *Marsilea minuta;* 16. *Dryopteris filix-mas*

Discussion

The present survey documented 16 species of ferns and fern allies from Dalma Wildlife Sanctuary, representing 10 genera under 8 families. Several taxa overlap with earlier reports from Ranchi and Latehar (Bharti & Pravesh, 2010). Literature records such as *Hemionitis arifolia* (Ghosh, Mallick, & Paik, 2026) extend the known distribution in Jharkhand, though this species was not encountered in our Dalma surveys. These findings align with broader patterns observed in Indian fern floras, where regional checklists (Dixit, 1984; Khullar, 1994; Manickam & Irudayaraj, 1992) consistently emphasize the role of microhabitats and altitudinal gradients in shaping species distribution. Taxonomic refinements by Fraser-Jenkins (2008) further underscore the importance of localized surveys in clarifying species identities and extending known ranges.

Species richness in Dalma was highest in mid-altitude zones, where canopy cover and humidity created favorable microhabitats. Moist ravines and stream margins supported taxa such as *Adiantum philippense* and *Marsilea minuta*, while epiphytic niches harbored *Pyrrosia lanceolata*. Seasonal variation was evident, with post-monsoon surveys yielding maximum diversity. These observations echo Khullar's (1994) emphasis on Himalayan fern ecology and Manickam & Irudayaraj's (1992) findings from South India, both of which highlight moisture availability as a critical determinant of fern distribution.

Common taxa such as *Adiantum caudatum*, *Pteris vittata*, and *Marsilea minuta* underline the adaptability of certain species across eastern India. At the same time, the presence of *Dryopteris filix-mas* in Dalma highlights the importance of microclimatic niches in conserving habitat-specific taxa. Ethnobotanical insights gathered from local communities revealed traditional uses of several species, paralleling earlier accounts from Ranchi and Latehar (Bharti & Pravesh, 2010). Similar practices have been documented among tribal groups in Singhbhum (Roy Chowdhury & Yadav, 2025) and the Santhal region of Jharkhand (Saha, 2024), underscoring continuity of fern-based remedies across eastern India. Broader ethnomedicinal surveys in Jharkhand (Singh, 2008) also highlight the decline of knowledge transmission, consistent with observations in Dalma, where younger generations show limited awareness of traditional uses.

Dalma's fern flora, however, faces mounting challenges. Mining, grazing, deforestation, and soil removal threaten the fragile habitats where these plants thrive. In particular, the removal of humus-rich forest soil directly impacts spore germination and juvenile establishment, processes critical for fern persistence (Khullar, 1994).

Figures

Figure I. Ex situ photographs of collected specimens. Images captured under controlled conditions to highlight diagnostic features such as frond architecture, sori arrangement, and rhizome morphology. These photographs complement in situ records and facilitate accurate taxonomic identification.

Figure II. In situ photographs of selected ferns from Dalma Wildlife Sanctuary. Species documented in natural habitats including shaded ravines, moist stream margins, rock crevices, and epiphytic niches. Each image is GPS-tagged with date, time, latitude, and longitude, providing verifiable evidence of occurrence and habitat association.

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References

Bharti, M., & Pravesh, R. (2010). Diversity, distribution and conservation priorities for pteridophytic flora of Ranchi and Latehar district of Jharkhand, India. *Indian Journal of Forestry, 33*(2), 233–240.

Botanical Survey of India. (2026). *Authentication of fern specimens collected from Dalma Wildlife Sanctuary*. Central National Herbarium, Howrah.

Delos Angeles, M. D., et al. (2025). Spatial diversity and distribution of fern and lycophyte species in karst and non-karst landscapes. *Frontiers in Plant Science, 16*, 112–124.

Dixit, R. D. (1984). *A census of the Indian Pteridophytes*. Botanical Survey of India.

Flores-Galván, D., et al. (2025). Conservation of steno-endemic ferns in karst landscapes. *Biodiversity and Conservation, 34*(5), 765–780.

Fraser-Jenkins, C. R. (2008). Taxonomic revision of Indian subcontinental pteridophytes. *Indian Fern Journal, 25*(1–2), 1–52.

Ghosh, R., Mallick, M. A. I., & Paik, S. (2026). First record of *Hemionitis arifolia* from Jharkhand State. *Journal of Threatened Taxa, 18*(4), 11234–11238.

Ihinmikaiye, S. O., & Ojo, V. I. (2026). Fern species diversity in Otuoke University Community, Nigeria: Patterns and conservation implications. *East African Scholars Journal of Agriculture and Life Sciences, 9*(2), 45–53.

Khullar, S. P. (1994). *An illustrated fern flora of the West Himalaya*. Bishen Singh Mahendra Pal Singh.

Magesh, C. R., & Rizvi, N. (2017). Indigenous knowledge of Santhal tribes of Dalma Wildlife Sanctuary, Jharkhand, India. *International Journal of Scientific Research, 6*(10), 576–577.

Manickam, V. S., & Irudayaraj, V. (1992). *Pteridophytes of South India*. Today & Tomorrow's Printers.

Páez, A., Aros-Mualin, D., Kessler, M., Kluge, J., & Meza-Torres, M. (2026). Global refuge effect of humid microhabitats for ferns decreases towards arid regions. *Ecology and Evolution, 16*(3), 221–233.

Prabhu, S. G., Srinikethan, G., & Hegde, S. (2016). Heavy metal phytoremediation potential of ferns. *Environmental Monitoring and Assessment, 188*(7), 421–430.

Roy Chowdhury, A., & Yadav, R. N. (2025). Ethnobotanical plants used by tribals of Singhbhum districts. *Journal of Ethnobotany Research and Applications, 23*(1), 56–64.

Saha, S. (2024). Ethnobotanical survey of ferns in Santhal region of Jharkhand. *Indian Journal of Traditional Knowledge, 23*(2), 345–352.

Sen, U. K., & Bhakat, R. K. (2021). Assessment of pteridophytes' composition and conservation status in sacred groves of Jhargram District, West Bengal. *Biodiversitas, 22*(8), 3456–3467.

Singh, N. P. (2008). Ethnobotany of Jharkhand: Traditional uses of ferns and allied plants. *Journal of Economic and Taxonomic Botany, 32*(1), 89–95.