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First Record of *Hemionitis arifolia* (Burm.f.) T.Moore from Jharkhand State and a Rare Sighting of *Didymocarpus pygmaeus* C.B.Clarke in Dalma Wildlife Sanctuary, India: Distributional Notes and Species-wise Ethnomedicinal Importance

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ABSTRACT

Floristic diversity of Jharkhand State remains inadequately documented, particularly with respect to rare and medicinally important plant taxa occurring within protected forest landscapes. The present communication reports the first confirmed record of *Hemionitis arifolia* from Jharkhand State and documents a rare sighting of *Didymocarpus pygmaeus* from Dalma Wildlife Sanctuary. *Hemionitis arifolia*, a shade-loving medicinal fern, was recorded from moist forest floor habitats and represents a notable range extension in eastern India. Ethnomedicinally, the species is traditionally used by indigenous communities for the treatment of skin diseases, wounds, ulcers, and inflammatory conditions; its fronds and rhizomes are also reported to possess antimicrobial and antioxidant properties, supporting its pharmaceutical relevance. *Didymocarpus pygmaeus*, a small and rarely encountered angiosperm, was observed growing on rocky and shaded forest slopes within the sanctuary. Local ethnobotanical knowledge indicates its use in the treatment of respiratory ailments, fever, and minor infections, while preliminary phytochemical studies from other regions suggest the presence of bioactive compounds with anti-inflammatory and therapeutic potential. The documentation of these two medicinally significant species highlights the ecological importance of Dalma Wildlife Sanctuary and

underscores the need for systematic botanical exploration, conservation of microhabitats, and preservation of traditional ethnomedicinal knowledge in Jharkhand.

Keywords: First record, Rare plant, Ethnomedicinal use, Medicinal fern, Pharmaceutical importance, Dalma Wildlife Sanctuary, Jharkhand flora, Plant diversity, *Hemionitis arifolia*, *Didymocarpus pygmaeus*

1. INTRODUCTION

India is recognized as one of the world's megadiverse countries, supporting an exceptionally rich flora that forms the basis of traditional healthcare systems and modern pharmaceutical research (Sen & Samanta, 2015; Bawa et al., 2021; Sharma et al., 2022; Raju & Das, 2024). Despite this biological wealth, several regions, particularly in eastern India, remain floristically underexplored. Jharkhand State, characterized by undulating terrain, dense sal (*Shorea robusta*) – dominated forests, rocky hill slopes, and seasonal streams, harbors a wide range of microhabitats that support diverse vascular plant assemblages (Singh, 2010; Kumar & Saikia, 2020). However, systematic documentation of rare, endemic, and medicinally important plant species from this region is still inadequate, resulting in significant gaps in our understanding of species distribution and conservation status.

Dalma Wildlife Sanctuary, one of the major protected areas of Jharkhand, represents an ecologically significant landscape within the Chota Nagpur Plateau (Kapure et al., 2020). The sanctuary supports heterogeneous vegetation types ranging from dry deciduous forests to moist, shaded niches along forest floors, rock crevices, and stream margins (Karuppusamy, 2024). Such microhabitats are particularly favorable for the occurrence of pteridophytes and narrowly distributed angiosperms (Watkins & Cardelús, 2012; Seidl et al., 2020). Owing to limited floristic surveys and increasing anthropogenic pressures such as habitat modification, grazing, and resource extraction, many plant taxa in this region remain poorly recorded or are known only from sporadic observations (Rouget et al., 2003; Kier et al., 2005; Corlett, 2016).

The genus *Hemionitis* comprises shade-loving medicinal ferns commonly associated with moist forest habitats (Goswami et al., 2016). *Hemionitis arifolia* is well known in traditional medicine for its therapeutic applications, particularly in the treatment of skin disorders, wounds, and inflammatory conditions (Kumar et al., 2015; Kalpana et al., 2015). Although the species has been reported from several parts of India, including the Western Ghats and northeastern regions (Kumar et al., 2011; Jeyaprakash & Balachandran, 2025), its occurrence in Jharkhand has not been previously documented. The present record therefore represents a significant extension of its known geographical distribution and adds to the pteridophytic diversity of the state. Similarly, *Didymocarpus pygmaeus* (Family: Gesneriaceae) is a small, rare, and habitat-specific angiosperm, usually confined to shaded rocky slopes and moist forested areas (Rana, 2018). Species of *Didymocarpus* are often valued for their medicinal properties in traditional systems, particularly for treating respiratory ailments, fever, and inflammatory disorders (Pandey et al., 2011; Chandra & Rawat, 2015; Naseem et al., 2024). However, due to their inconspicuous growth habit and restricted ecological preferences, many species within this genus remain underreported (Prasanna & Gowda, 2020). The rare sighting of *D. pygmaeus* in Dalma Wildlife Sanctuary highlights the sanctuary's role as a refuge for uncommon and medicinally important plant taxa.

Ethnomedicinal knowledge forms a crucial link between biodiversity conservation and human well-being, especially among indigenous and forest-dependent communities (Parrotta & Agnoletti, 2011; Tesfaye & Bezabih, 2017). Plants such as *H. arifolia* and *D. pygmaeus* are traditionally used in local healthcare practices, and their reported pharmacological properties have drawn increasing scientific attention (Al-Fatimi, 2024; Anwar et al., 2024). Documenting such species not only contributes to floristic inventories but also provides baseline information for future phytochemical, pharmacological, and conservation-oriented studies.

In this context, the present study aims to document the first record of *Hemionitis arifolia* from Jharkhand State and report a rare occurrence of *Didymocarpus pygmaeus* from Dalma Wildlife Sanctuary. The study further emphasizes the species-wise ethnomedicinal and pharmaceutical importance of these taxa and underscores the need for continued botanical exploration and conservation of fragile forest microhabitats in eastern India.

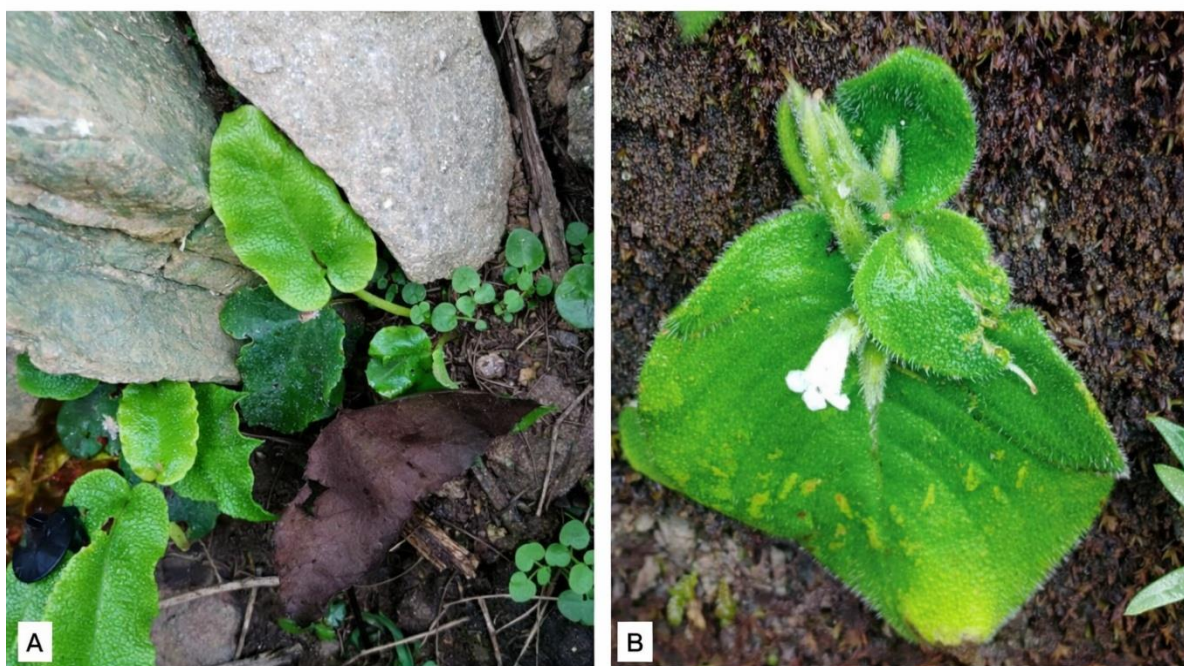


Figure 1. *Hemionitis griffolia* in shaded, moist rocky habitat. B. *Didymocarpus pygmaeus* (Pygmy stone Flower), two medinally important species recorded in Jharkhand, India, growing in shaded moist rocky microhabitats.

2. MATERIALS AND METHODS

Morphology and Plant Description of *Hemionitis arifolia*

Hemionitis arifolia is a small to medium-sized terrestrial fern distinguished by its simple, entire, and cordate to sagittate fronds, which are characteristic of the genus. The fronds arise in a basal rosette from a short, creeping to sub-erect rhizome. Rhizomes are covered with thin, brown to dark-brown scales, aiding in anchorage within rock crevices and moist substrates.

Fronds are dimorphic or weakly monomorphic, 6–15 cm long, with a long, slender stipe that is dark brown to blackish at the base and lighter upward. The lamina is ovate-cordate to

arrow-shaped, thick, leathery, and glossy green on the upper surface, while the lower surface appears slightly paler. Margins are entire and smooth, and the apex is obtuse to slightly acute. Venation is free, with veins radiating from the basal region and branching towards the margins. Sori are borne on the abaxial (lower) surface of fertile fronds, distributed along the veins and often forming irregular linear or patch-like arrangements. True indusia are absent; instead, sori are partially protected by the reflexed laminar margins, a feature typical of *Hemionitis*. Sporangia are numerous, containing trilete spores adapted for dispersal in humid forest microclimates.

Habitat and Ecology

In Jharkhand, *Hemionitis arifolia* was recorded for the first time from the Musabani forest of Jamshedpur Forest Division in 2019. The species occurs in hilly terrain, preferring shady and moist microhabitats with minimal direct sunlight. It was found growing in narrow crevices and on the surfaces of moist metamorphic and sedimentary rocks, where water seepage maintains high humidity throughout much of the year. The fern was observed in association with other moisture-loving pteridophytes and geophytes, including lip ferns (*Cheilanthes* spp.), *Drimia indica*, and *Selaginella* species. Such assemblages indicate stable, undisturbed microhabitats with consistent moisture availability. The presence of *H. arifolia* in these niches highlights its sensitivity to habitat alteration and its value as an indicator of intact forest floor and rocky slope ecosystems. *Hemionitis arifolia* growing naturally in a shaded, moist rocky crevice within hilly forest terrain of Musabani Forest, Jamshedpur Forest Division, Jharkhand, India, showing characteristic cordate fronds adapted to humid microhabitats (Photograph taken in 2019).

Distributional Note

Hemionitis arifolia has not been previously reported from Jharkhand and is absent from Haines' "The Botany of Bihar and Orissa", which historically covered much of the present-day Jharkhand region. The present record therefore represents a significant extension of its known distribution in eastern India and adds to the pteridophytic diversity of the state.

Taxonomic Note

Hemionitis arifolia (Burm.f.) Moore can be readily distinguished from other sympatric ferns occurring in rocky and xeric-mesic habitats of Jharkhand by its simple, entire, cordate to sagittate fronds. Unlike most members of the genus *Cheilanthes* (lip ferns), which commonly co-occur in the same microhabitats, *H. arifolia* lacks deeply divided or pinnate fronds. *Cheilanthes* species typically possess pinnatifid to bipinnate laminae, farinose or scaly abaxial surfaces, and marginally reflexed segments forming false indusia, whereas *H. arifolia* exhibits a single, undivided lamina with smooth entire margins and sori arranged irregularly along the veins on the abaxial surface.

In comparison with *Pteris* species, which may also occur in shaded rocky slopes, *H. arifolia* differs in having cordate laminae with free venation rather than linear sori along the margins and more elongated fronds characteristic of *Pteris*. *Adiantum* species, another common associate in moist forests, are easily separated by their fan-shaped pinnules, black wiry stipes, and marginal sori, features absent in *H. arifolia*. The thick, leathery texture, glossy adaxial surface, and heart-shaped outline of the lamina are key diagnostic characters that support the correct identification of *H. arifolia* in the field.

Conservation Status and Threat Assessment

Globally, *Hemionitis arifolia* is not currently assessed as threatened and is generally considered locally common to occasional in parts of its known range. However, at the state level in Jharkhand, the species should be regarded as locally rare, as it is newly recorded and restricted to specialized microhabitats. Its occurrence is confined to shady, moist rock crevices and forest floor niches, which are highly sensitive to environmental disturbance.

Major threats include habitat degradation due to mining activities, forest fragmentation, stone quarrying, soil erosion on hill slopes, and reduction of canopy cover leading to loss of humidity. Additionally, unregulated collection of forest resources and trampling can directly affect fragile pteridophytic populations. Given its narrow ecological amplitude and patchy distribution, *H. arifolia* may be vulnerable to microhabitat alteration. Regular monitoring, habitat protection, and inclusion of such species in regional conservation planning are therefore recommended.

Ethnomedicinal Importance

Hemionitis arifolia holds considerable ethnomedicinal significance in various parts of India, where it is traditionally used by indigenous and rural communities. The fresh fronds and rhizomes are commonly applied as a paste or decoction for the treatment of skin diseases, wounds, ulcers, burns, and inflammatory conditions. In some traditional practices, leaf extracts are used to alleviate itching, eczema, and fungal infections.

Pharmacological reports from other regions indicate that the species contains bioactive compounds with antimicrobial, antioxidant, and anti-inflammatory properties, supporting its traditional medicinal use. The presence of such therapeutic properties highlights its potential pharmaceutical value and underscores the importance of conserving natural populations. Documentation of its occurrence in Jharkhand also provides an opportunity to preserve associated traditional knowledge systems before they are lost due to cultural and environmental changes.

Morphology and Plant Description of *Didymocarpus pygmaeus*

Pygmy Stone Flower (*Didymocarpus pygmaeus* (Dalzell) C.B. Clarke) is a minute, delicate, annual herb belonging to the family Gesneriaceae. The plant is characteristically velvet-hairy and extremely small, often overlooked in the field due to its dwarf habit and short life cycle. The stem is slender, curved, and very short, measuring about 0.4–2.5 cm in height, usually bearing a single terminal leaf.

The leaf is elliptic-ovate to ovate, measuring $2-8 \times 1.2-6.5$ cm, though often much smaller in shaded rocky habitats. It is oblique, thin, blunt at both apex and base, densely covered with fine hairs, and bright green in color. The petiole is extremely short or absent (0–2 mm), giving the plant a sessile appearance against rock surfaces.

Flowers are solitary or few, borne on short peduncles 5–8 mm long. The flowers are white, tubular, and small, measuring 2–5 mm in length. The sepals are linear, 2–5 mm long, and hairy. There are two fertile stamens, accompanied by two linear staminodes. The ovary and style are hairy, while the stigma is small, subcapitate, and weakly two-lobed. The capsule is 1.5–2 cm long, nearly straight, and 2-valved, containing numerous minute seeds adapted for dispersal in moist habitats.

Didymocarpus pygmaeus (Pygmy Stone Flower) growing on a moist, shaded rocky surface in Dalma Wildlife Sanctuary, Jharkhand, India, showing its characteristic single-leaf habit, dense pubescence, and small white tubular flower (Photograph taken on 11 September 2022).

Taxonomic Note

Didymocarpus pygmaeus can be distinguished from other congeners by its extremely reduced stem, single-leaf habit, and minute white tubular flowers. Unlike larger species of *Didymocarpus*, which bear multiple leaves and more conspicuous inflorescences, *D. pygmaeus* shows a pygmy growth form, likely an adaptation to ephemeral moisture availability on rocky substrates.

It was earlier described under the synonym *Roettlera pygmaea*, but subsequent taxonomic revisions based on floral morphology placed it correctly within *Didymocarpus*. The dense pubescence, short peduncles, and linear sepals are key diagnostic characters separating it from other small gesneriads occurring in peninsular and central India.

Distribution Note

The species is native to north-western and central India, where it occurs sporadically in moist rocky habitats. The present observation represents a rare and significant sighting from Dalma Wildlife Sanctuary, Jharkhand, extending its known distribution eastwards within the Chota Nagpur Plateau region. Its presence in Dalma indicates the availability of undisturbed, humid microhabitats, particularly shaded rock faces and forest slopes that retain moisture during the monsoon season.

Status and Conservation Assessment

Didymocarpus pygmaeus is considered rare and localized throughout its range. Although it has not been formally assessed under the IUCN Red List, at the regional level (Jharkhand) it should be treated as locally rare and vulnerable. The species is highly dependent on specific microhabitats, such as moist rock surfaces and shaded forest floors, which are susceptible to disturbance.

Major threats include habitat loss due to quarrying, soil erosion, forest degradation, trampling, and changes in moisture regimes. Because the plant is small, annual, and seasonal, population sizes may fluctuate greatly between years, increasing its vulnerability. Protection of rocky forest microhabitats and regular monitoring during the flowering season are essential for its conservation.

Ethnomedicinal Importance

Ethnomedicinal information on *Didymocarpus pygmaeus* is limited due to its rarity and diminutive size; however, related species within Gesneriaceae are traditionally used for treating fever, respiratory ailments, inflammation, and minor infections. Local knowledge from parts of central India suggests that crushed plant material is occasionally used in folk remedies for coughs and skin irritation.

The presence of dense hairs and reported therapeutic use in allied taxa indicates potential anti-inflammatory and antimicrobial properties, warranting further phytochemical and pharmacological investigation.

Traditional Knowledge

Traditional knowledge related to forest plants forms an integral part of the cultural heritage of indigenous and forest-dependent communities of Jharkhand, where herbal remedies are widely used for primary healthcare. Although detailed ethnobotanical documentation from the study area is limited, local knowledge systems indicate that small ferns and herbaceous plants growing in moist, shaded forest habitats are commonly valued for their curative properties. *Hemionitis arifolia* is traditionally recognized in several parts of India as a medicinal fern, with its fresh fronds or rhizomes used in the form of pastes or decoctions to treat skin ailments, cuts, wounds, burns, ulcers, and inflammatory conditions. Such practices are often based on empirical observations passed orally through generations, particularly among tribal healers and elderly community members.

In contrast, *Didymocarpus pygmaeus*, due to its minute size, seasonal appearance, and localized distribution, is less widely known; however, allied species within the Gesneriaceae are traditionally used to manage fever, cough, respiratory discomfort, and minor infections. In some regions of central India, crushed plant material of small gesneriads is reportedly applied externally for skin irritation and swelling, suggesting a shared ethnomedicinal rationale within the group. The reliance on these plants reflects a close relationship between local communities and their surrounding ecosystems, where knowledge of habitat, seasonality, and plant identity plays a crucial role in effective use.

The rapid erosion of traditional knowledge due to socio-economic changes, reduced dependence on forest resources, and habitat degradation poses a serious threat to this intangible heritage. Therefore, systematic documentation of traditional uses associated with rare and medicinally important plants such as *Hemionitis arifolia* and *Didymocarpus pygmaeus* is essential. Preserving and integrating this knowledge with scientific research can support sustainable utilization, promote conservation awareness, and provide valuable leads for future pharmacological investigations.

3. DISCUSSION

The present study provides significant additions to the floristic knowledge of Jharkhand by documenting the first state record of *Hemionitis arifolia* and a rare sighting of *Didymocarpus pygmaeus* from Dalma Wildlife Sanctuary and adjoining forest areas (Figure 2). Both species are habitat-specific and associated with shaded, moist rocky microenvironments, underscoring the ecological importance of such niches within the forested landscapes of the Chota Nagpur Plateau.

The absence of *H. arifolia* from earlier floristic works, including Haines' *The Botany of Bihar and Orissa*, suggests either historical under-sampling of cryptic pteridophytic habitats or a genuinely restricted and localized distribution that has remained undetected until now.

The occurrence of *Hemionitis arifolia* in the Musabani forest of Jamshedpur Forest Division represents a notable eastward extension of its known distribution range in India. Its association with moist metamorphic and sedimentary rock surfaces, along with co-occurring taxa such as *Cheilanthes* spp., *Drimia indica*, and *Selaginella* spp., indicates a stable microclimatic regime characterized by high humidity, shade, and minimal disturbance. Such conditions are critical for the survival of many pteridophytes, particularly those with delicate fronds and limited drought tolerance.

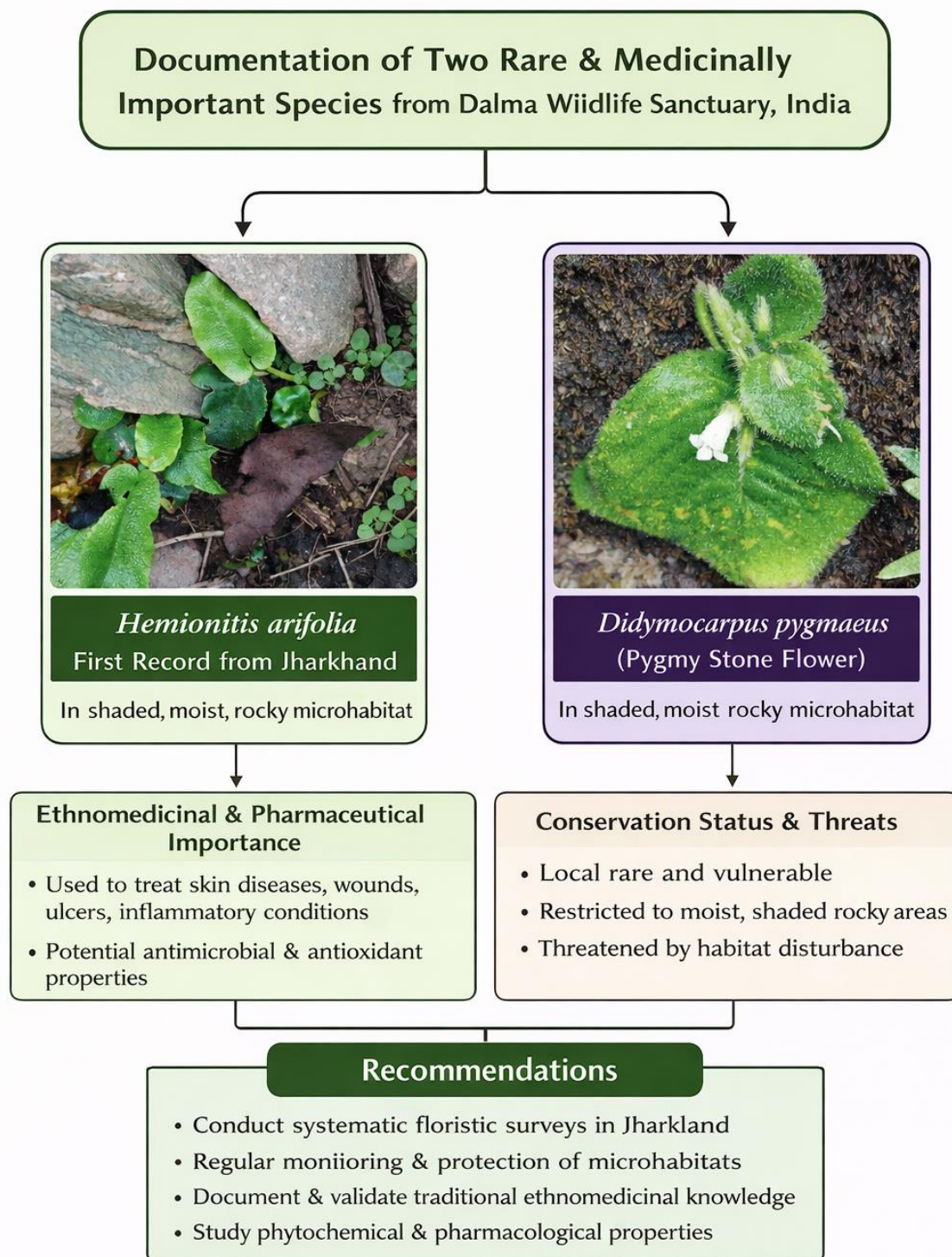


Figure 2. Flowchart summarizing the documentation, conservation significance, and recommendations for the rare plant species *Hemionitis arifolia* and *Didymocarpus pygmaeus* from Dalma Wildlife Sanctuary, Jharkhand, India.

The discovery of this species highlights the need for focused surveys targeting microhabitats that are often overlooked in conventional floristic assessments.

Similarly, *Didymocarpus pygmaeus* is a diminutive and ephemeral angiosperm with highly specific ecological requirements. Its rare occurrence in Dalma Wildlife Sanctuary reflects the presence of intact rocky forest slopes that retain moisture during the monsoon season. The pygmy habit, single-leaf morphology, and short flowering period of this species contribute to its underrepresentation in botanical collections and literature. The present record extends its known distribution into eastern India and reinforces the view that Dalma Wildlife Sanctuary serves as an important refuge for rare and narrowly distributed plant species.

From a conservation perspective, both species demonstrate vulnerability at the regional scale due to their dependence on specialized microhabitats. Anthropogenic pressures such as mining, quarrying, forest degradation, and changes in canopy structure pose serious threats by altering moisture regimes and substrate stability. Pteridophytes like *H. arifolia* are particularly sensitive to microclimatic fluctuations, while annual herbs such as *D. pygmaeus* are susceptible to habitat disturbance during their short life cycle. The restricted and patchy distribution observed for both taxa suggests that even minor habitat alterations could lead to local population declines.

The ethnomedicinal relevance of these plants further enhances their significance. *Hemionitis arifolia* is widely recognized in traditional medicine for its applications in treating skin disorders, wounds, and inflammatory conditions, supported by reports of antimicrobial and antioxidant properties. Although ethnomedicinal information on *Didymocarpus pygmaeus* is limited, its taxonomic affiliation with medicinally valued gesneriads suggests potential therapeutic importance. The presence of such medicinally useful plants within protected forest areas emphasizes the need to conserve not only species diversity but also associated traditional knowledge systems.

Overall, the findings of this study highlight the importance of intensive, habitat-focused botanical surveys in revealing overlooked components of regional biodiversity. The documentation of these species from Jharkhand fills critical gaps in distributional data and provides a baseline for future ecological, pharmacological, and conservation-oriented research. Protecting moist rocky microhabitats within Dalma Wildlife Sanctuary and adjacent forest areas should be prioritized to ensure the long-term persistence of such rare and medicinally important plant taxa.

4. CONCLUSIONS

The present study documents the first confirmed record of *Hemionitis arifolia* from Jharkhand State and reports a rare occurrence of *Didymocarpus pygmaeus* from Dalma Wildlife Sanctuary, thereby making important contributions to the floristic inventory of eastern India. The occurrence of both species in shaded, moist, rocky microhabitats highlights the ecological significance of such niches within the forested landscapes of the Chota Nagpur Plateau. Their absence or rarity in earlier floristic accounts suggests that these taxa have either been historically overlooked due to their cryptic nature and restricted habitats or have highly localized distributions. In addition to their biogeographical importance, both species possess notable ethnomedicinal and pharmaceutical relevance, emphasizing the need to integrate botanical exploration with traditional knowledge documentation.

The findings underscore the role of Dalma Wildlife Sanctuary and adjoining forest areas as important reservoirs of rare, habitat-specific, and medicinally valuable plant species, warranting focused conservation attention.

Recommendations

Based on the findings of the present study, systematic and season-specific floristic surveys should be conducted across Jharkhand, with special emphasis on moist rocky slopes, shaded forest floors, and microhabitats that are often neglected in routine botanical assessments. Regular population monitoring of *Hemionitis arifolia* and *Didymocarpus pygmaeus* is recommended to assess their abundance, reproductive success, and long-term survival. Conservation measures should prioritize the protection of microhabitats from disturbances such as mining, quarrying, deforestation, and trampling, particularly within and around Dalma Wildlife Sanctuary. Documentation and validation of ethnomedicinal knowledge associated with these species should be encouraged in collaboration with local communities, alongside scientific studies on their phytochemical and pharmacological properties. Finally, inclusion of such rare and medicinally important taxa in regional conservation planning and biodiversity management strategies will be crucial for ensuring their sustained protection and for strengthening plant conservation efforts in Jharkhand.

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References

- [1] Al-Fatimi, M. (2024). Traditional knowledge of wild plants on traditional tools, materials, products and economic practices in southern Yemen. *Journal of Ethnobiology and Ethnomedicine*, 20(1), 62
- [2] Anwar, T., Qureshi, H., Shahzadi, S., Siddiqi, E. H., Ali, H. M., Abdelhamid, M. M., & Nazim, M. (2024). Exploring the benefits of wild plants in dietary nutrition: investigating perspectives, choices, health impacts and sustainable practices. *BMC Complementary Medicine and Therapies*, 24(1), 86
- [3] Bawa, K. S. et al. (2021). Securing biodiversity, securing our future: A national mission on biodiversity and human well-being for India. *Biological Conservation* 253, 108867
- [4] Chandra, S., & Rawat, D. S. (2015). Medicinal plants of the family Caryophyllaceae: a review of ethno-medicinal uses and pharmacological properties. *Integrative Medicine Research*, 4(3), 123-131
- [5] Corlett, R. T. (2016). Plant diversity in a changing world: status, trends, and conservation needs. *Plant Diversity*, 38(1), 10-16
- [6] Goswami, H. K., Sen, K., & Mukhopadhyay, R. (2016). Pteridophytes: evolutionary boon as medicinal plants. *Plant Genetic Resources*, 14(4), 328-355

- [7] Jeyaprakash, K., & Balachandran, N. (2025). Diversity of flowering plants in the Sathuragiri hills, Tamil Nadu, Southern Western Ghats, India. *Species*, 26, e37s3169
- [8] Kalpana Devi, R., Rajesh, N. V., Vasantha, S., & Sathia Geetha, V. (2015). Anti-parasitic action of *Actinopteris radiata*, *Acrostichum aureum* and *Hemionitis arifolia*. *Pteridological Res*, 4(1), 1-9
- [9] Kapure, S., Singh, M., & Gupta, R. K. (2020, June). Technological Innovations for Developing Sustainable Ecotourism in High Mountain Region of Jamshedpur, Jharkhand:-A case study of Dalma Wildlife Sanctuary. In 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) (pp. 723-727). IEEE.
- [10] Karuppusamy, S. (2024). Vegetation and Forest Types of the Western Ghats. In Biodiversity Hotspot of the Western Ghats and Sri Lanka (pp. 25-61). Apple Academic Press.
- [11] Kier, G., Mutke, J., Dinerstein, E., Ricketts, T. H., Küper, W., Kreft, H., & Barthlott, W. (2005). Global patterns of plant diversity and floristic knowledge. *Journal of Biogeography*, 32(7), 1107-1116
- [12] Kumar, K. K., AP, J., & KK, S. (2015). Antidiabetic evaluation of *Hemionitis arifolia* leaves by in vitro methods. *Manipal Journal of Pharmaceutical Sciences*, 1(1), 4
- [13] Kumar, R. B., Anitha, K., Watve, A., Mani, S., Rehel, S., & Arisdason, W. (2011). The status and distribution of aquatic plants of the Western Ghats. S. Molur, KG Smith, BA Daniel, and WRT Darwall [compilers], The status and distribution of freshwater biodiversity in the Western Ghats, India, 49-62.
- [14] Kumar, R., & Saikia, P. (2020). Floristic analysis and dominance pattern of sal (*Shorea robusta*) forests in Ranchi, Jharkhand, eastern India. *Journal of Forestry Research*, 31(2), 415-427
- [15] Naseem, N., Khaliq, T., Jan, S., Nabi, S., Sultan, P., Hassan, Q. P., & Mir, F. A. (2024). An overview on pharmacological significance, phytochemical potential, traditional importance and conservation strategies of *Dioscorea deltoidea*: A high valued endangered medicinal plant. *Heliyon*, 10(10)
- [16] Pandey, M., Debnath, M., Gupta, S., & Chikara, S. K. (2011). Phytomedicine: An ancient approach turning into future potential source of therapeutics. *Journal of Pharmacognosy and Phytotherapy*, 3(3), 27-37
- [17] Parrotta, J. A., & Agnoletti, M. (2011). Traditional forest-related knowledge and climate change. In Traditional forest-related knowledge: Sustaining communities, ecosystems and biocultural diversity (pp. 491-533). Dordrecht: Springer Netherlands.
- [18] Prasanna, N. S., & Gowda, V. (2020). Rediscovery of four narrow endemic *Didymocarpus* species (Gesneriaceae) from Mizoram, India, with revised species descriptions and lectotypifications. *PhytoKeys*, 148, 1
- [19] Raju, S., & Das, M. (2024). Medicinal plants industry in India: Challenges, opportunities and sustainability. *Medicinal Plants-International Journal of Phytomedicines and Related Industries*, 16(1), 1-14

- [20] Rana, K. G. (2018). Status of Endemic and Threatened Angiosperms of Gujarat (Doctoral dissertation, Maharaja Sayajirao University of Baroda (India).
- [21] Rouget, M., Richardson, D. M., Cowling, R. M., Lloyd, J. W., & Lombard, A. T. (2003). Current patterns of habitat transformation and future threats to biodiversity in terrestrial ecosystems of the Cape Floristic Region, South Africa. *Biological Conservation*, 112(1-2), 63-85
- [22] Seidl, C. M., Basham, E. W., Andriamahohatra, L. R., & Scheffers, B. R. (2020). Bird's nest fern epiphytes facilitate herpetofaunal arboreality and climate refuge in two paleotropic canopies. *Oecologia*, 192(2), 297-309
- [23] Sen, T., & Samanta, S. K. (2015). Medicinal plants, human health and biodiversity: a broad review. *Biotechnological Applications of Biodiversity*, 147: 59-110
- [24] Sharma, P. K., Singh, A., & Sharma, N. K. (2022). A socio-ecological critique on India's local health traditions amidst rising incidence of global pandemics. *Journal of Herbal Medicine*, 34, 100578
- [25] Singh, S. P. (2010). Impact of forest degradation on carbon density in soil and vegetation of *Shorea robusta* (Sal) forests in the part of Siwalik Hills of Dehradun, India, using geospatial techniques. Dehradun: Indian Institute of Remote Sensing, National Remote Sensing Center, Indian Space Research Organization, 97.
- [26] Tesfaye, B., & Bezabih, B. (2017). Indigenous knowledge and factors related to practices of forest conservation among forest dependent communities in the Tocha district Southern Ethiopia. *Agriculture, Forestry and Fisheries*, 6(1), 6-19
- [27] Watkins Jr, J., & Cardelús, C. L. (2012). Ferns in an angiosperm world: Cretaceous radiation into the epiphytic niche and diversification on the forest floor. *International Journal of Plant Sciences*, 173(6), 695-710