Research Article

Verdant Treasures: Unveiling the Ecological Distribution, Conservation Status, and Medicinal Marvels of *Pogonatum* species in India-A Holistic Review

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ABSTRACT

Pogonatum moss is a fascinating plant that has garnered a lot of attention because of its wide range of biological distribution, potential medical benefits, and conservation implications. This thorough analysis explores the complex story of *Pogonatum* moss, also referred to as "the beard moss," explaining its widespread distribution, state of conservation, and extraordinary therapeutic potential. To give readers a comprehensive understanding of *Pogonatum* moss, "Verdant Treasures: Unveiling the Ecological Distribution, Conservation Status, and Medicinal Marvels of *Pogonatum* species-A Holistic Review" synthesizes a plethora of scientific knowledge. This review highlights the importance of *Pogonatum* in the ecological and biomedical domains, urging more study and conservation efforts. It does this by illuminating the plant's ecological role, conservation requirements, and therapeutic potential.

Keywords: *Pogonatum*, Geographical distribution, Conservation status, Medicinal properties.

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INTRODUCTION

In the past, bryophytes, which refer to different types of land plants, have traditionally been classified into three main groups: liverworts, hornworts, and mosses. However, bryophytes can be more accurately classified into three groups based on morphological, molecular, and phytochemical characteristics. Anthocerotophytes that includes hornworts. Bryophytes comprise mosses, including peat, lantern and haircap mosses. Marchantiophyta includes both leafy and thalloid liverworts. In total, there are 24,000 species of bryophytes throughout the world.[1] Around 8000 moss species have been identified, along with 6000 species of liverworts and 200 species of hornworts.[2] Bryophytes are considered the second-largest group of land plants after angiosperms in terms of size. India hosts a diverse bryophyte population, totalling 2504 species, contributing to 17.27% of the world's bryophyte species. Among them, 642 species are exclusive to India, demonstrating a significant 25.6% endemism. The moss fauna in India comprises 1786 species and 355 genera, while liverworts are categorized into 121 genera and 675 species. In the country, there are a total of 25 species and 6 genera which represent hornworts.[3]

Bryophytes belong to the category of cryptogams, characterized by the absence of seeds and flowers. Their relatively small size contributes to lower biomass, rendering them less familiar to the general public.[4] Since ancient times, bryophytes have found utility in various applications such as packaging, plugging, and decoration. Beyond their ornamental uses, bryophytes play crucial roles as indicator species, aiding in erosion control and serving as bioindicators for heavy metals. Additionally, these versatile plants can function as bioindicators for aquatic environments, radioactivity, and even as a potential fuel source.[5,6] Bryophytes

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contain several active components that exhibit diverse properties, including antimicrobial, antifungal, cytotoxic, antitumor, and insecticidal activities.[7,8]

Pogonatum, commonly referred to as "the beard moss," is a fascinating genus of mosses that has captivated the interest of botanists, ecologists, and taxonomists. With its diverse species and global distribution, *Pogonatum* offers an intriguing subject for research on morphological variation and geographic distributions. Understanding the characteristics and ecological preferences of *Pogonatum* species not only contributes to our knowledge of moss biodiversity but also provides valuable insights into their adaptations and evolutionary history.

Pogonatum P. Beauv. is the most diverse genus within the Polytrichaceae family, comprising over 50 species.[9] This genus is easily recognized by its thick, rough textured leaves and hairy calyptra. In India, this genus is represented by 18 species.[10-12]

RESULTS

Table 1: List of *Pogonatum* species found in India.

Sl. No.	Species	Distribution in India	IUCN Status	Synonyms
1	*Pogonatum aloides*	Darjeeling, Sikkim, Shimla, Mussoorie, Garhwal, Kumaon, Assam, Nilgiri hills, Palni hills, Tamil Nadu (Haduvattum).[13]	Least Concern[14]	Not Applicable.
2	*Pogonatum cirratum*	Darjeeling.[13]	Not Applicable.[14]	*Pogonatum flexicaule, Pogonatum fuscatum*
3	*Pogonatum contortum*	Khasia Hills, Manipur, Darjeeling.[13]	Not Applicable.[14]	Not Applicable
4	*Pogonatum fastigiatum*	Sikkim, K. and J. hills, Darjeeling.[13]	Not Applicable.[14]	Not Applicable.
5	*Pogonatum inflexum*	South India.[13]	Not Applicable.[14]	Not Applicable.
6	*Pogonatum macrophyllum*	Assam[13]	Not Applicable.[14]	Not Applicable.
7	*Pogonatum microstomum*	Sikkim, Garhwal, Kumaon, Garhwal, Bombay, K. and J. hills, Naga hills, W. Himalaya, Nilgiri, Palni, W. Ghats, Tamil Nadu, Karnataka, Meghalaya, Eastern Ghats (Orchidarium road).[13]	Not Applicable.[14]	Not Applicable.
8	*Pogonatum neesii*	Eastern Ghats (Sanyasi hills)[13]	Not Applicable.[14]	*Pogonatum akitense, Pogonatum junghuhnianum, Pogonatum leucopogon, Pogonatum papillosulum, Pogonatum stevensii.*
9	*Pogonatum nudiusculum*	K. and J. hills (Shillong), Darjeeling, Sikkim, Khasia hills.[13]	Not Applicable.[14]	Not Applicable.
10	*Pogonatum patulum*	Upper Palni hills, Kodaikanal.[13]	Not Applicable.[14]	*Pogonatum hexagonum, Pogonatum strictifolium.*
11	*Pogonatum perichaetiale*	Darjeeling, Sikkim, Shimla, Mussoorie, Garhwal, Kumaon, W. Himalayas, Nilgiri, Tamil Nadu, Eastern Ghats (Shervarayan temple peak).[13]	Not Applicable.[14]	Not Applicable.
12	*Pogonatum proliferum*	K. and J. Hills, Manipur, Naga hills, Darjeeling, Khasia hills.[13]	Not Applicable.[14]	*Pogonatum gymnophyllum.*
13	*Pogonatum rufisetum*	Sikkim, Darjeeling.[13]	Not Applicable.[14]	Not Applicable.
14	*Pogonatum subtortile*	Palni hills, Darjeeling, Sikkim.[13]	Not Applicable.[14]	Not Applicable.
15	*Pogonatum thomsonii*	N. W. Himalayas.[13]	Not Applicable.[14]	Not Applicable.
16	*Pogonatum tortile*	Sikkim[13]	Not Applicable.[14]	Not Applicable.
17	*Pogonatum urnigerum*	W. Himalaya, Kashmir, Tamil Nadu, Eastern Ghats.[13]	Least Concern.[14]	*Pogonatum himalayanum.*

Table 2: List of medicinal properties or Phytochemical Composition of *Pogonatum* species.

Sl. No.	Species	Medicinal Property or Phytochemical Composition
1	*Pogonatum aloides*	Not studied.
2	*Pogonatum cirratum*	Antioxidant property.[15]
3	*Pogonatum contortum*	Contains alkaloids, phenolics, triterpenoids/steroids and terpenoids.[16]
4	*Pogonatum fastigiatum*	Not studied
5	*Pogonatum inflexum*	16 compounds were identified tricin (1), irisflorentin (2), 3,5,4'-trihydroxy-7,3'-dimethoxyflavone (3), 3,5,3'-trihydroxy-7,4'-dimethoxyflavanone (4), 5,2'-dihydroxy-6,7-methylenedioxy- flavanone (5), 5,2',3'-trihydroxy-6,7-methylenedioxyflavanone (6), apigenin (7), kaempferol (8), kaempferide (9), naringenin (10), quercetin (11), baicalein (12), luteolin (13), protocatechuic aldehyde (14), 4-hydroxy-3-methoxy-benzaldehyde (15), and 2-hydroxy-5-(2-hydroxy-4- methoxybenzyl)-4-methoxybenzaldehyde (16).[17]
6	*Pogonatum macrophyllum*	i) To reduce inflammation (Anti-inflammatory activity) and fever, as detergent diuretic, laxative and hemostatic agent.[18]
7	*Pogonatum microstomum*	Flavonoids, glycosides, triterpenoids, phenols and sterols are present also shows Antimicrobial properties.[19]
8	*Pogonatum neesii*	Anticancer activity.[20]
9	*Pogonatum nudiusculum*	Not studied.
10	*Pogonatum patulum*	Not studied.
11	*Pogonatum perichaetiale*	Not studied.
12	*Pogonatum proliferum*	Not studied.
13	*Pogonatum rufisetum*	Not studied.
14	*Pogonatum subtortile*	Not studied.
15	*Pogonatum thomsonii*	Not studied.
16	*Pogonatum tortile*	Not studied.
17	*Pogonatum urnigerum*	Not studied.

DISCUSSION

Table 1 provides a thorough summary of the distribution and status of various *Pogonatum* species across different regions in India. The data highlights the diverse ecological preferences of these species and reveals distinct distribution patterns.

Distribution Patterns

The *Pogonatum* species is found in many parts of India, ranging from Tamil Nadu and Kerala in the south to the most northern areas, such as Darjeeling and Sikkim. These species' broad distribution demonstrates their great level of tolerance to a variety of climatic and environmental conditions.

Biodiversity Hotspots

For the *Pogonatum* species, several areas stand out as biodiversity hotspots. The biological richness and importance of Darjeeling, Sikkim, and the Western Himalayas are demonstrated by the abundance of species that inhabit these areas. The *Pogonatum* species diversity is also greatly enhanced by the Kumaon and Khasia hills.

Altitudinal Range

Pogonatum species distribution over a wide range of altitudinal ranges from the lower hills to the high altitudes of the Himalayas indicates their capacity to adapt to changing climatic circumstances. In light of potential future climate changes, this adaptability is essential.

Status

Pogonatum aloides and *Pogonatum urnigerum* are categorized as Least Concern[14] by the IUCN, signifying that these species currently face no significant risk of extinction. The conservation status for the remaining *Pogonatum* species is labeled as Not Applicable, indicating that they may not have been assessed by the IUCN for their conservation status.

Ecological Significance

The ecological relevance of *Pogonatum* species is indicated by their presence in a variety of environments, including hills, mountains, and the Eastern Ghats. These species might support pollinator interactions, nitrogen cycling, and ecological stability.

Conservation Strategies

Conservation efforts should consider the different distribution patterns and ecological requirements of *Pogonatum* species. Important efforts in the conservation of these species include the establishment of protected areas, the rehabilitation of damaged areas, and the protection of important ecosystems.

In conclusion, researchers and conservationist can learn a great deal about the distribution and condition of *Pogonatum* species in India. This information emphasizes the significance of these species' conservation in the face of changing environmental conditions and the necessity for thorough research to fully understand the ecological complexities of these species.

The displayed Table 2 offers important information about the phytochemical composition and medicinal properties of different *Pogonatum* species.

Diverse Medicinal Properties

The *Pogonatum* species that are included in Table 2 have a wide range of medicinal uses. These characteristics include laxative, diuretic, hemostatic, antibacterial, antioxidant, anti-inflammatory and anticancer actions. These characteristics point to the potential benefits of *Pogonatum* species for promoting health and well-being in many ways, from treating fever and inflammation to acting as antimicrobials.

Phytochemical Diversity

The phytochemical compounds identified within the *Pogonatum* species underscore the rich chemical diversity present in these plants. The compounds include phenols, triterpenoids, alkaloids, glycosides, flavonoids, and sterols. The 16 chemicals found in *P. inflexum*, including tricin, quercetin, and kaempferol, are well-known for their anti-inflammatory and antioxidant characteristics. Given the diversity of phytochemicals found in *Pogonatum* species, it is possible that these plants could produce bioactive substances with medical uses.

Potential Medicinal Applications

Many *Pogonatum* species have unique therapeutic properties that have been traditionally associated with them. For example, *P. macrophyllum* is a possible option for the treatment of inflammatory disorders because of its known anti-inflammatory and fever-reducing properties. Similarly, the flavonoids, glycosides, and phenolic chemicals found in *P. microstomum* provide it with antibacterial properties. These findings demonstrate the importance of traditional knowledge in helping to identify possible medicinal applications.

Future Research Directions

To fully investigate the range of the therapeutic potential of *Pogonatum* species, more investigation is necessary. Studies conducted *in vivo* and *in vitro* can assist in confirming the traditional applications and pinpointing the precise mechanisms of action of these plants. Furthermore, the identification and description of specific compounds can offer a more profound comprehension of their possible medicinal uses, particularly in the case of species such as *P. inflexum* that have several known compounds.

In conclusion, a wide range of phytochemical compounds and a variety of therapeutic characteristics are displayed by the *Pogonatum* species covered in Table 2. The results of this study provide a basis for additional research on these herbs in conventional medicine and contemporary drug discovery. We may be able to utilize the medicinal potential of *Pogonatum* species for the betterment of human health by integrating traditional knowledge with modern research.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

***P.*:** *Pogonatum*; **IUCN:** International Union for Conservation of Nature.

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SUMMARY

The review paper comprehensively covers the distribution, conservation status, synonyms, and medicinal properties of *Pogonatum* species, showcasing their remarkable diversity and potential therapeutic significance. *Pogonatum* species have a vast geographical distribution, ranging from the northern covers of Darjeeling, Sikkim, and the Himalayas to the southern territories of Tamil Nadu and Karnataka. While some species enjoy a status of Least Concern according to

the IUCN, others remain unassessed, highlighting the need for further research and conservation efforts. Additionally, the paper elucidates the medicinal properties and phytochemical compositions of select *Pogonatum* species, shedding light on their potential applications in healthcare and pharmaceuticals.

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