

Diversity and distribution of the genus *Meconopsis* Vig . (Papaveraceae) in the Indian Himalayan region

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Abstract

The present work provides a comprehensive overview of status and distribution of genus *Meconopsis* Vig .(Papaveraceae) in the Indian Himalayan Region (IHR). Critical assessment of published literature and herbarium records on the diversity, distribution and endemism of the genus *Meconopsis* Vig. have been carried for the review. A total 22 taxa of *Meconopsis* is recorded from the IHR, out of which only 7 are reported to the Western Himalayan region (Uttarakhand, Himachal Pradesh, Jammu & Kashmir & Ladakh UT), whereas Eastern Himalaya (Arunachal Pradesh, Sikkim, West Bengal (Darjeeling Hills) is enriched with 19 taxa and 5 taxa are observed common for Western and Eastern Himalayan region. Highest *Meconopsis* diversity was observed in Arunachal Pradesh (13 taxa) followed by Sikkim (11 taxa). Several new taxa viz. *Meconopsis gakyidiana*, *M. prainiana* var. *prainiana*, *M. prainiana* var. *lutea*, *M. merakensis* var. *merakensis*, *M. merakensis* var. *albolutea* and *M. baileyi* subsp. *pratensis* are recently recorded from Arunachal Pradesh. The *Meconopsis* taxa are mainly distributed in the alpine ecosystem ranging from 3000-4200 masl. Conservation strategy is also proposed for protection of *Meconopsis* taxa in the IHR.

Key words *Meconopsis*, Papaveraceae, Distribution, Indian Himalayan Region, Conservation

INTRODUCTION

European species, *Papaver cambricum* L. by Viguiier (1814) established. Mostly herbaceous, the genus is native to the high-altitude areas of the Himalayas distributed from India, Pakistan, Nepal, Bhutan, Myanmar, to China. *Meconopsis* comprises c. 50 – 80 species (Grey- Wilson 2014; Xiao & Simpson 2017). Grey-Wilson (2014) recognised 79 species in his book Genus *Meconopsis*. Blue Poppies and their relatives (in comparison to 41 species recognised by Taylor). Earlier, Debnath & Nayyar (1993) recorded 16 species of *Meconopsis* in India in his work on Papaveraceae. The genus is characterized by large saucer-shaped blue, yellow, white, purple and red flowers. The majority of *Meconopsis* species are used in traditional herbal medicine systems (Kala 2003) and some species are also cultivated as ornamentals for their attractive flowers. The genus exhibits wide morphological variation in terms of height, ranging from a few centimetres to 2 meters. The plants occur along a wide altitudinal gradient from 2000 to 5000 m. Taxonomic studies on the genus *Meconopsis* have been carried out by several authors based on morphological (Prain 1906; Kingdon-Ward 1926; Taylor & Cox 1934; Wu & Chuang 1980; Grey-Wilson 2014; Yoshida *et al.* 2017), cytological (Kumar *et al.* 2013) and molecular phylogenetic traits (Xiao & Simpson 2015, 2017). Morphological and recent molecular studies have raised concern regarding the taxonomy of *Meconopsis* and *Papaver* L. Comprehensive molecular studies need to be carried out to resolve the taxonomical ambiguity of the genera. Some species of *Meconopsis* have been merged/ transferred in the genus *Papaver*. However, the most recent and authentic literature, viz. Grey-Wilson (2014), Xiao & Simpson (2017) and Yoshida *et al.* (2017) is followed for taxonomic treatment of *Meconopsis* genus in this article.

India, the genus has been reported and inventoried by various workers from IHR in their floristic diversity work (Kachroo *et al.* 1977; Sharma & Kachroo 1981; Blatter 1984;

Polunin & Stainton 1984; Chowdhary & Wadhwa 1984; Stainton 1988; Aswal & Mehrotara 1999; Singh & Rawat 2000; Uniyal *et al.* 2007; Sekar & Srivastava 2009; Pusalkar & Singh 2012; Bharali *et al.* 2018). Considering the medicinal and aesthetic importance of the *Meconopsis* genus, the present article provides comprehensive overview of diversity, distribution in IHR and neighbouring countries and endemism. Conservation and management challenges and options are also presented for preservation of *Meconopsis* genus in the Himalayan region.

METHODOLOGY

Comprehensive review of existing published literature on *Meconopsis* genus was documented from books, research papers, monographs (Wu & Chuang 1980; Grey-Wilson 2014; Yoshida *et al.* 2016; Xiao & Simpson 2017). E-flora of China, Nepal, Pakistan and Myanmar was searched for *Meconopsis* distribution in neighbouring countries. The plant list (<http://www.theplantlist.org/>) and Plants of the world online (<http://powo.science.kew.org>) and International Plant Name Index (IPIN) (<https://www.ipni.org/n/77103138-1>) websites were searched for accepted names of taxa and distribution records and other related information. Field study was conducted in Arunachal Pradesh, Himachal Pradesh, Uttarakhand, Ladakh UT and *Meconopsis* specimens collected and deposited in GBPI herbaria. Critical study of herbarium specimens housed at various National institutions such as the Botanical Survey of India, State Forest Research Institute (SFRI), Itanagar, Rajiv Gandhi University (HAU), Arunachal Pradesh, GB Pant National Institute of Himalayan Environment (GBPI-NIHE) and International online herbaria of Royal Botanic Gardens, Kew, United Kingdom and BM, E, K, P, PE, US were conducted to assess the diversity and distribution of *Meconopsis* in the Himalayan region. Further personal communication with the experts (Dr. Grey-Wilson & Mr. T. Yoshida), were held for *Meconopsis* specimens identification and distribution status in IHR. The taxa of *Meconopsis* are counted and listed in state-wise representation. For distribution study the Indian Himalayan regions are divided into Eastern Himalaya (Arunachal Pradesh, Sikkim, West Bengal (Darjeeling Hills),) and Western Himalaya (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Ladakh Union Territory). The taxa have been listed alphabetically with altitude and distribution in the Indian states and the adjacent countries.

RESULTS AND DISCUSSION

A total 22 taxa of *Meconopsis* was recorded from the IHR, out of which only 7 are reported to the Western Himalayan region (Uttarakhand, Himachal Pradesh, Jammu & Kashmir & Ladakh UT), while Eastern Himalaya (Arunachal Pradesh, Sikkim, West Bengal (Darjeeling Hills)) is enriched with 19 taxa and 5 taxa are observed common for Western and Eastern Himalayan region (Table 1 & Figure 1). Maximum concentration of the taxa is observed at an altitudinal gradient between 3000 – 4500 m amsl (10 taxa). Highest *Meconopsis* diversity was observed in Arunachal Pradesh (13 taxa) followed by Sikkim (11 taxa), Jammu and Kashmir and Ladakh UT (4 taxa each), Uttarakhand and Himachal Pradesh (3 taxa each) and West Bengal-Darjeeling Hills (2 taxa) (Figure 2). Several new taxa *viz.* *Meconopsis gakyidiana*, *M. prainiana* var. *prainiana*, *M. prainiana* var. *lutea*, *M. merakensis* var. *albolutea* and *M. baileyi* subsp. *Pratensis* are recently recorded from Arunachal Pradesh and these taxa are endemic to the Arunachal Pradesh state. *M. merakensis* var. *merakensis* is recently recorded from Arunachal Pradesh and it is only reported from Bhutan previously. Thus, Arunachal Himalaya can be considered as a hotspot for *Meconopsis* species. The *Meconopsis* taxa are mainly distributed in the alpine ecosystem ranging from 2000–4800 amsl. Though Debnath & Nayar (1993) has recorded 16 taxa of *Meconopsis* from IHR however, the present study suggest that the diversity of taxa in the IHR is 23 taxa. The *Meconopsis* taxa recorded in the IHR, are also well distributed in the neighbouring countries *viz.* China and Bhutan (16 taxa), Nepal (10 taxa), Myanmar (5

taxa), and Pakistan (3 taxa). *M. discigera*, *M. grandis*, *M. lyrata*, *M. superb* and *M. primulina* taxa are endemic to Sikkim in the IHR. Whereas, *M. neglecta* is endemic to Jammu and Kashmir of IHR.

Table 1. Distribution of *Meconopsis* taxa in the Indian Himalayan Region

Name of Taxa	Altitudinal range (meter)	Distribution in IHR	Distribution in other Countries	References
<i>Meconopsis aculeata</i> Royle	2400 – 4200	Himachal Pradesh, Jammu & Kashmir, Ladakh UT, Uttarakhand	China, Pakistan	Debnath & Nayar 1993
<i>M. baileyi</i> subsp. <i>pratensis</i> Kingdon-Ward ex Grey-Wilson	3000 – 4500	Arunachal Pradesh	Myanmar	Bharali <i>et al.</i> 2018
<i>M. bella</i> Prain subsp. <i>subintegrifolia</i> Grey-Wilson	3700 – 4600	Sikkim, Arunachal Pradesh	Nepal, Bhutan, China	Debnath & Nayar 1993
<i>M. betonicifolia</i> Franch.	2000 – 3000	Arunachal Pradesh	China, Myanmar	Debnath & Nayar 1993
<i>M. discigera</i> Prain	3600–4100	Sikkim	Nepal, Bhutan, China	Debnath & Nayar 1993
<i>M. gakyidiana</i> T. Yoshida, R. Yangzom & D.G. Long	3700 – 4300	Arunachal Pradesh	China, Bhutan	Yoshida <i>et al.</i> 2017
<i>M. grandis</i> Prain	3650 – 4200	Sikkim	Nepal, Bhutan, China, Myanmar	Debnath & Nayar 1993
<i>M. horridula</i> Hook.f. & Thomson	3800 – 4700	Arunachal Pradesh, Jammu & Kashmir, Sikkim, Ladakh UT	Nepal, Bhutan, China, Myanmar	Debnath & Nayar 1993
<i>M. latifolia</i> (Prain) Prain	3000 – 4000	Arunachal Pradesh, Jammu & Kashmir	Pakistan	Debnath & Nayar 1993
<i>M. lyrata</i> (H.A. Cummins & Prain) Fedde ex Prain	3000 – 4500	Sikkim	Nepal, China, Myanmar	Debnath & Nayar 1993
<i>M. merakensis</i> T. Yoshida, R. Yangzom & D. G. Long var. <i>merakensis</i>	3800 – 4500	Arunachal Pradesh	Bhutan	Kanwal <i>et al.</i> 2020, Yoshida <i>et al.</i> 2017
<i>M. merakensis</i> var. <i>albolutea</i> T. Yoshida, R. Yangzom & D.G. Long	3800 – 4500	Arunachal Pradesh	Bhutan	Yoshida <i>et al.</i> 2017
<i>M. neglecta</i> G.Taylor	3000 – 4000	Jammu & Kashmir	Pakistan	Debnath & Nayar 1993
<i>M. paniculata</i> (D.Don) Prain	2000 – 4000	Arunachal Pradesh, Sikkim, Uttarakhand, West Bengal (Darjeeling Hills)	Nepal, Bhutan, China,	Debnath & Nayar 1993
<i>M. prainiana</i> Kingdon-Ward var. <i>prainiana</i>	3500 – 4500	Arunachal Pradesh	China, Bhutan	Yoshida <i>et al.</i> 2017
<i>M. prainiana</i> var. <i>lutea</i> Ludlow, Sherriff & Taylor	3500 – 4500	Arunachal Pradesh	China, Bhutan	Yoshida <i>et al.</i> 2017

Name of Taxa	Altitudinal range (meter)	Distribution in IHR	Distribution in other Countries	References
<i>M. primulina</i> Prain	3000 – 4200	Sikkim	Bhutan, China	Chaudhuri 1993
<i>M. robusta</i> Hook.f. & Thomson	2400 – 4100	Himachal Pradesh, Uttarakhand	Nepal	Debnath & Nayar 1993
<i>M. simplicifolia</i> (D.Don) Walp.	2000 – 3500	Arunachal Pradesh, Sikkim, Ladakh UT	Nepal, Bhutan, China,	Debnath & Nayar 1993
<i>M. sinuata</i> Prain	3800 – 4500	Sikkim, Ladakh UT	Nepal, Bhutan, China	Debnath & Nayar 1993
<i>M. superba</i> King ex Prain	2500 – 3800	Sikkim	Bhutan, China	Debnath & Nayar 1993
<i>M. villosa</i> (Hook.f.) G. Taylor	2700 – 4300	Arunachal Pradesh, Sikkim, West Bengal (Darjeeling Hills)	Nepal, Bhutan	Debnath & Nayar 1993

■ Eastern Himalaya ■ Western Himalaya ■ Common in EH & WH

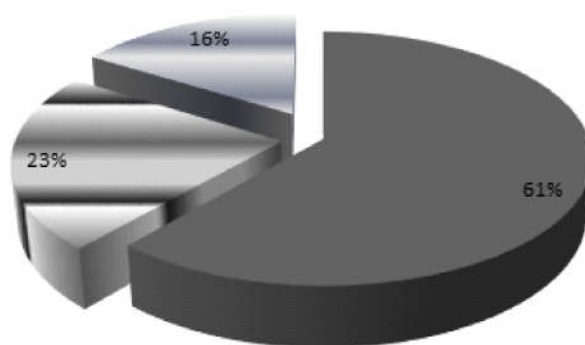


Figure 1. Distribution of *Meconopsis* taxa in Eastern and Western Himalayan Region

Meconopsis has various medicinal properties and indigenous communities of IHR use various parts of plant for different ethnomedicinal uses. *Monpa* community of Tawang district, Arunachal Pradesh uses syrup prepared from dry leaf and dry flowers of *Meconopsis grandis* and *Meconopsis paniculata* for the treatment of sexually transmitted disease. *Amchis* traditional healers of Ladakh Trans Himalaya region use the whole plant extract of *M. aculeata* for the treatment of stomachache. Bhutia community of Sikkim uses *M. simplicifolia* rhizome for renal problem treatment.

Meconopsis taxa is facing threat from diverse anthropogenic activities such as overgrazing of livestock, mainly from trampling by yaks and horses, unregulated tourism, development works that result in the destruction and fragmentation of the species habitat. In the future, the species may face further threats due to climate change in IHR. *Meconopsis* species are particularly sensitive to climate change due to their restricted distribution in the alpine and sub-alpine ecosystems. The fragile ecosystem and unique climatic conditions of high altitude areas are more vulnerable to the effects of climate change. The high altitude regions are characterized by extreme cold, dry and alpine climate conditions, particularly due to low air temperature and higher ultraviolet radiation. Empirical scientific studies have highlighted that the high altitude region of IHR are more vulnerable due to climate change impact. Seven species of *Meconopsis*

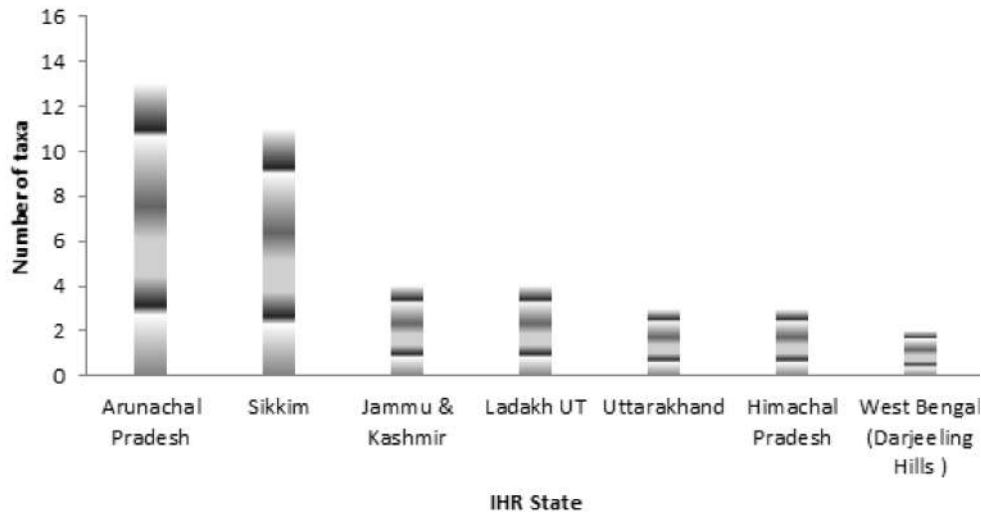


Figure 2. Distribution of genus *Meconopsis* in IHR states

have shown an upward shift in mean elevation of 302.3 m between the pre 1970s (1922–1969) and the post 1970s (1970–2016) in the Himalaya–Hengduan Mountains region (He *et al.* 2019). Therefore, endemic and rare *Meconopsis* taxa, with very small populations and special habitats, need special attention for conservation.

Botanical exploration in IHR particularly in Eastern Himalayan region may record some new *Meconopsis* taxa in the country's flora. Population assessment of *Meconopsis*, *in-situ* and *ex-situ* conservation, habitat protection, bio-prospecting of *Meconopsis* species and climate change mitigation and management measures are immediately required for conservation of diversity of this amazing Blue poppy (*Meconopsi*) taxa in the IHR.

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