

## Perspective of the genus *Delphinium* Linnaeus (Ranunculaceae) in India

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### Abstract

The present work deals with enumeration of 27 species, one sub-species and one variety of the genus *Delphinium* Linnaeus (Ranunculaceae) from India. Out of total 29 taxa, 15 are confined to the Western Himalayan region, while Eastern Himalaya is enriched with 11 taxa, one species, *D. malabaricum* is endemic to Western Ghats of South India. The genus forms the group of high altitude flowering plants and maximum diversity has been observed between 4000 – 4500 m asl. Very showy flowers for ornamental purposes and variety of alkaloids having spectacular medicinal values add the economic

**Key words:** *Delphinium*, Ranunculaceae, Diversity, India

### INTRODUCTION

The Ranunculaceae A. Jussieu, commonly known as buttercup or crowfoot family, consists of 59 genera and ca. 2,500 species of annual to perennial herbs, shrubs, or woody climbers, cosmopolitan in nature, however most of the members are concentrated in temperate to alpine regions in northern hemisphere (Tamura 1993; Takhtajan 1997; Wang *et al.* 2001). Ranunculaceae includes plants with primitive features to the plants with very advanced and evolved features such as finely dissected leaves, raceme inflorescence, unisexual and zygomorphic flowers, specialized spurred sepals and petals, syncarpy and achene fruits. *Delphinium* Linnaeus is one such advanced genus in the family, different species of which are commonly known as “Larkspur”. The genus acquired its name from Greek word *delphis* for dolphin, referring to the shape of nectar and it represents a group of very beautiful annuals, rarely biennials or perennials herbs (Figure 1). The genus has ca. 370 species (Blanché 1991) distributed in North temperate regions of the world. Munz (1967 & 1968) documented 244 species from Asia with the centre of diversity in South-West China and Eastern Himalaya where *Delphinium* has 150 species (Wang & Warnock 2001). In India the genus is represented by 27 species and two infra-specific taxa, mainly confined to the temperate and alpine zones of the Himalayas (Rau 1993) and one species, *D. malabaricum* is endemic to Western Ghats of South India. Himalayas has been considered as primary centre for speciation in the genus (Blanche 1990), which also suggest that these taxa could have undergone particular evolution process.

The genus *Delphinium* encompassing medicinal and poisonous plants are important genetic resource for cut flower cultivars (Kolar *et al.* 2011) characterized by violet-blue

petalloid sepals, zygomorphic and spurred flowers with hidden nectariferous petals (Hoot 1991; Johansson & Jansen 1993). Diterpenoid alkaloids, are assumed to be main bioactive components of the genus and more than 200 such compounds have so far been isolated (Hari *et al.* 2011). On the one hand, the genus is medicinally exploited for variety of pharmacological properties, such as analgesic, antiarrhythmic, anti-inflammatory, arrhythmogenic, curariform, hypotensive, neurotropic, psychotropic, and spasmolytic (Dzhakhangirov *et al.* 1995; Prajapati & Kumar 2003; Turabekova & Rasulev 2004; Chen *et al.* 2011; Mantena *et al.* 2011), while on the other hand, the plants have also been the cause of poisoning that primarily occur in cattle as well as human beings, due to toxicity of their alkaloids (Ameri 1998; Turabekova & Rasulev 2004).

Indian Himalayan Region (IHR) harbours a rich floristic diversity (17,000 species of flowering plants) with 33.5% of endemism (Nayar 1996). Among Ranunculaceae (one of the few leading Himalayan families exhibiting high degree of 72.7% endemism), *Delphinium* was reviewed as one of the endemism rich taxa by Dhar (2002). In India, the genus is represented by 27 species, 1 sub-species and 1 variety, which are chiefly distributed in the temperate to alpine zones of the Indian Himalayas. These taxa have been inventoried in different Himalayan regions from Kashmir to North-East India in various floristic studies taken up by several workers (Hooker 1879; Bamber 1916; Collett 1921; Hara 1966; Gupta 1968; Singh and Kachroo 1976; Nair 1977; Raizada 1978; Sharma & Kachroo 1981; Blatter 1984; Polunin & Stainton 1984; Chowdhery & Wadhwa 1984; Naithani 1985; Sharma & Jamwal 1988; Kapur & Sarin 1990; Hajra & Balodi 1995; Uniyal & Thothathari 1997; Aswal & Mehrotra 1999; Singh & Rawat 2000; Kaur & Sharma 2004; Pusalkar & Singh 2012). The present paper deals with the enumeration of *Delphinium* in IHR as well as regions.

## METHODOLOGY

To accomplish the objective of enumeration of total taxa of *Delphinium* Linnaeus and their distribution pattern in India, extensive literature survey and herbarium consultation was done. Data from published literature and unpublished records of herbarium collections provided useful perspectives on the distributional pattern and existing taxa of this genus. For the purpose, all major Indian herbaria (CAL, DD, LWG, BSD, ASSAM, KASH, RRLH etc.) and international herbaria (K and BM) having collections of Indian taxa of *Delphinium* were consulted. The species of *Delphinium* were calculated and enumerated in state wise representation. For the distribution of species IHR, the study area was divided into Eastern Himalaya and Western Himalaya. The Eastern Himalaya includes the states of West Bengal (Darjeeling district), Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. In the same way, the Western Himalaya covers Jammu & Kashmir, Himachal Pradesh and Uttarakhand. The species have been listed alphabetically with altitude, distribution in Indian States and other countries.

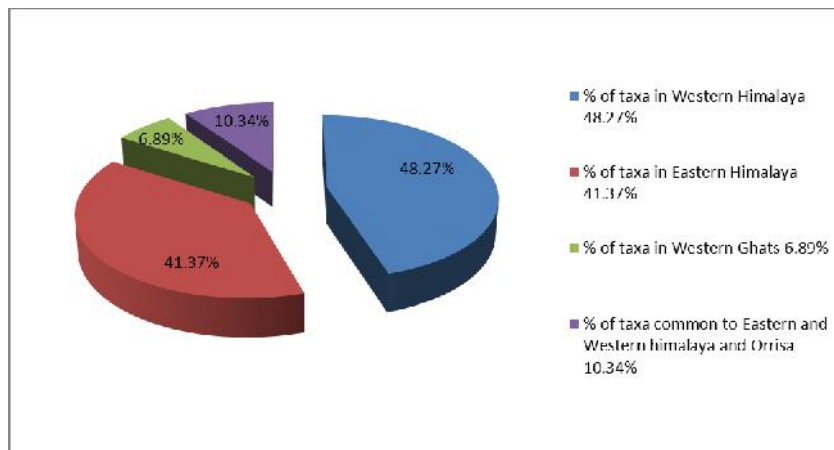
## RESULT AND DISCUSSION

A total of 27 species of *Delphinium*, one subspecies (*D. elatum* subsp. *alpinum*) and one variety (*D. malabaricum* var. *ghaticum*) have been recorded from India (Table 1). The genus has wide distributional range in the Himalayas and covers equally both Western and Eastern Himalayas. Western Himalaya has 14 species which are confined to the region and do not share their distribution with the Eastern Himalaya. Similarly, Eastern Himalaya is enriched with 11 species and one sub-species of *Delphinium*. Two species, namely *D. caeruleum* and *D. pyramidale* are distributed in both the regions.

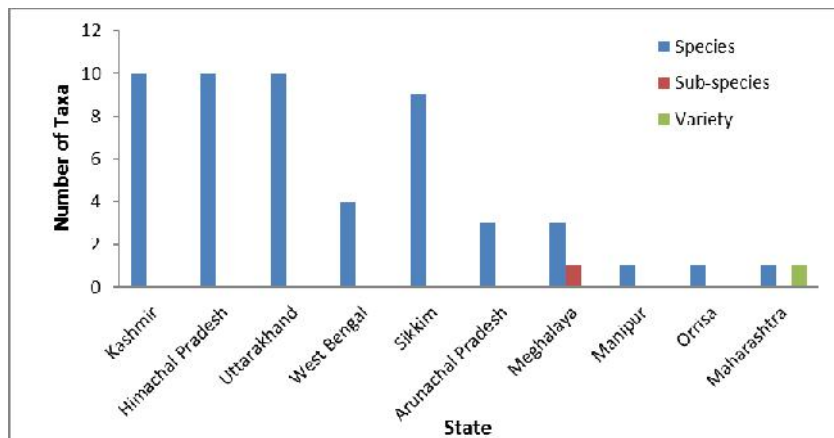
**Table 1.** Distribution of the genus *Delphinium* Linnaeus in India and adjacent countries [Abbreviations for Indian state names: A.P.=Arunachal Pradesh; H.P. = Himachal Pradesh; J.&K. = Jammu & Kashmir; SK=Sikkim; MG = Meghalaya; MH = Maharashtra; MN = Manipur; OD = Odisha; Utk = Uttarakhand; W.B. = West Bengal]

Name of Taxa	Altitude in Metres	Distribution	
		India	Other countries
<i>D. altissimum</i> Wallich	1400 – 2500	SK, AP, MG, MN	Bhutan, China, Nepal
<i>D. brunonianum</i> Royle	3100 – 6000	J. & K., H.P., Utk	Afghanistan, Nepal, China, Pakistan
<i>D. caeruleum</i> Jacquin	3800 – 5800	H.P., Utk, SK, W.B.	Bhutan, China, Nepal
<i>D. candelabrum</i> Ostenfeld	4500 – 5200	SK	China, Bhutan
<i>D. cashmerianum</i> Royle	2800 – 5000	J.& K., H.P., Utk	China, Pakistan
<i>D. densiflorum</i> Duthie ex Huth	3000 – 6000	H.P., Utk	Nepal, China
<i>D. denudatum</i> Wallich ex Hooker f. & Thomson	1525 – 4000	J.& K., H.P., Utk	Pakistan
<i>D. drepanocentrum</i> (Brühl ex Huth) Munz	3500 – 5000	SK	Nepal, Bhutan, China
<i>D. glaciale</i> Hooker f. & Thomson	5000 – 6500	SK, W.B.	Nepal, Bhutan, China
<i>D. incisum</i> (Hooker f. & Thomson) Wallich ex Munz	2000 – 3000	Utk	Nepal
<i>D. kingianum</i> Brühl ex Huth	4000 – 4800	SK	China
<i>D. koelzii</i> Munz	1600	H.P.	
<i>D. kohatense</i> (Brühl) Munz	2000 – 3500	J.& K.	Pakistan, Afghanistan
<i>D. kamaonense</i> Huth	3000 – 4500	Utk	Nepal
<i>D. lacostei</i> Danguy	4000 – 5500	H.P.	Pakistan, China
<i>D. ludlowii</i> Munz	2700 – 3700	SK	Bhutan
<i>D. malabaricum</i> (Huth) Munz var. <i>malabaricum</i>	900 – 1200	MH	
<i>D. malabaricum</i> (Huth) Munz var. <i>ghaticum</i> Billore	900 – 1200	MH	
<i>D. micropetalum</i> Finet & Gagnepain	3300 – 4400	J.& K.	Nepal, China, Myanmar
<i>D. nortonii</i> Dunn	4000 – 5000	SK	China, Nepal
<i>D. pyramidale</i> Royle	2000 – 3500	J.& K., H.P., Utk, W.B.	Pakistan, Nepal, China
<i>D. roylei</i> Munz	1600 – 4200	J.& K., H.P., Utk, OD	
<i>D. scabriflorum</i> D. Don	1500 – 2400	A.P., MG	Nepal, Bhutan
<i>D. stapeliosum</i> Brühl ex Huth	2000 – 3000	MG	Nepal, Bhutan, Myanmar, China
<i>D. uncinatum</i> Hooker f. & Thomson	1200 – 2000	J.& K.	Pakistan, Afghanistan
<i>D. vestitum</i> Wallich ex Royle	2250 – 4500	J.& K., H.P., Utk	Nepal, China, Pakistan
<i>D. viscosum</i> Hooker f. & Thomson	3600 – 4700	SK, A.P., W.B.	Nepal, China, Myanmar
<i>D. nordhagenii</i> Wendelbo	4500 – 5000	J.& K.	Pakistan, China
<i>D. elatum</i> Linnaeus ssp. <i>alpinum</i> (Waldstein & Kitaibel) Tzvelev	1500 – 2000	MG	

One species *D. malabaricum* and one variety are exclusively found in the Western Ghats of South India (Figure 1). Out of the total taxa of the genus *Delphinium*, 5 taxa (17 %) are endemic to India. The maximum concentration of the species is observed in Western Himalaya, where its three states Jammu & Kashmir, Himachal Pradesh and Uttarakhand are holding equal number of taxa (10) in each, out of which 4 species are endemic to Jammu & Kashmir, 2 species to Uttarakhand and 2 species to Himachal Pradesh, where *D. koelzii* is endemic at global level. In Eastern Himalaya, Sikkim has been identified as most favourable habitat for Larkspur, where 9 taxa are found distributed, out of which 5 are confined to the region. One taxon *D. elatum* subsp. *alpinum* is endemic to Meghalaya at global level (Figure 2). *D. altissimum* is the only species reported from Manipur, it was collected from Dzukou valley, on the border of Nagaland and Manipur at an altitude of 2450 m. Two taxa namely *D. malabaricum* var. *malabaricum* and *D. malabaricum* var. *ghaticum* are strictly endemic to Maharashtra. Another species, namely *D. roylei* has been reported also from Odisha (Paul 1975) on the basis of one specimens deposited at LWG (G. Saran & Party 58060) at an altitude of 1500 m in Mahendragiri, although it was just a single collection and after that no more collection has been made from this locality. The type locality for *D. roylei* is Purbunee, Kashmir and its occurrence from Odisha in the Eastern part of India is interesting from phytogeographical point of view.



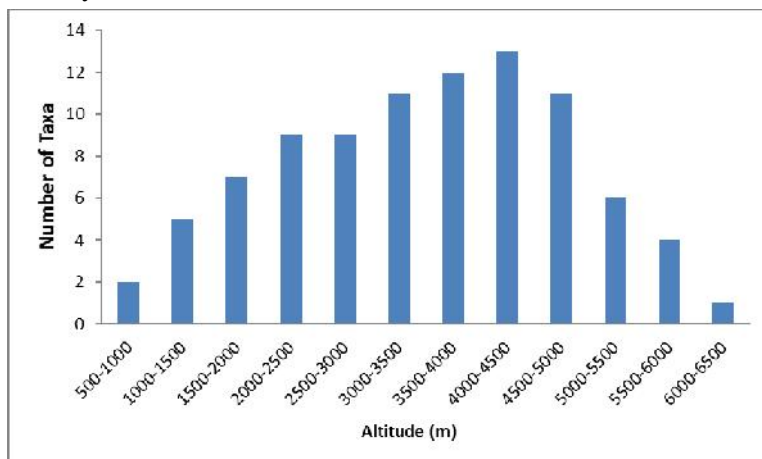
**Figure 1.** Distribution of infra-specific taxa of *Delphinium* in India



**Figure 2.** Distribution of the genus *Delphinium* in different states in India



**PLATE – 1.** a. *D. vestitum* Wallich ex Royle; b. *D. denudatum* Hooker f. & Thomson; c. *D. viscosum* Hooker f. & Thomson; d. *D. roylei* Munz; e. *D. brunonianum* Royle; f. *D. cashmerianum* Royle



**Figure 3.** Altitudinal distribution of the genus *Delphinium* in India

The distribution and growth of *Delphinium* is directly related to the specific climate and geography of the ecological niche. The distribution of *Delphinium* plotted against the altitudinal gradient, which reveal a hump-shaped curve as depicted in Figure 3. Maximum concentration of taxa of *Delphinium* are found between 4000 – 4500 m asl. As evident from the figure, most of the taxa are found in sub-alpine and alpine zones of the Himalayas and forms a group of high altitude flowering plants suggesting a unimodal relationship between species richness and altitude. Species richness was found to be affected by increasing altitude and was highest in the mid-altitudinal ranges viz. 3000 – 3500 (11 taxa), 3500 – 4000 m (12 taxa), 4000 – 4500 m (13 taxa), 4500 – 5000 (11 taxa). One species *D. glaciale* is found distributed at 6500 m amsl and forms the group of high altitude flowering plants. The reduction in species in higher altitudinal gradient could be attributed to eco-physiological constraints, such as extremely low temperature, short period of growing season and geographical barriers. Further, the lower altitudes were in a regime of frequent anthropogenic disturbances, such as road construction, habitation and agricultural practices, which resulted in replacement of natural vegetation with man-made ecosystems consisting of plantations and agriculture. The preferred habitats of *Delphinium* species are debris, calcareous scree and cultivated fields, which are generally unstable and susceptible to disappearance because of rock falls and avalanche. Although, pastures among fixed big blocks at the base of scree offer relatively stable habitats.

*Delphinium* species are of horticultural importance and medicinal use (Turabekova *et al.* 2010; Zhao *et al.* 2010). Chemical constituents of plants belonging to genus *Delphinium* have been extensively studied and are best known for their diverse C19 and C20 alkaloids having analgesic properties (Wang & Liang 1992; Diaz *et al.* 2000). More than 40 alkaloids have been identified in Larkspur, which varies in type and amount between different Larkspur species, within different Larkspur population and different phenological stages. Individual plants contain 15 or more alkaloids (Pelletier *et al.* 1977). Pastes of *Delphinium* flowers and extracts of roots have been used as insecticides and as ingredients of drugs for dysentery, diarrhea, as tonic for toothache, as cardiac and respiratory depressants and also as a stimulant (Said 1970; Prajapati & Kumar 2003). Several derivatives of norditerpenoid lycoctonine alkaloid have been isolated from roots and leaves of *D. brunonianum*, *D. vestitum* and *D. denudatum* (Bhandary *et al.* 1990; Rahman *et al.* 1997). They have antifungal activities also against human and plant pathogenic fungi and antifeedant properties for insects including *Spodoptera littoris* and *Lepinoptera decemlineata* (Rahman *et al.* 1997; Ganzalez-Colona *et al.* 1998). Biomolecules from *D. denudatum* are also known as potential cures for human diseases and also in morphine de-addiction (Zafar *et al.* 2001). Aqueous extracts from roots have been shown antiepileptic properties (Raza *et al.* 2001). Larkspur species has been considered as rare plant groups, but its precise conservation status has not been determined. Few species of *Delphinium* (*D. caseyi*) has been enlisted as critically endangered in the Red List of IUCN for which *in-situ* conservation measures have been taken but needs to conserve by *ex-situ* means also. Despite the small population size and presence of poisonous alkaloids, *Delphinium* species are frequently grazed by cattle. Significant damage could be seen as most of the plants are completely eaten in their upper parts. The recent progressive approach of humans to rich biodiversity naturally protected areas has caused many conservation problems in the Himalayas. The need for restriction of free public access and load of visitors to rich heritage biodiversity areas have become cautionary measures. Himalayan tourism is a serious threat to *Delphinium* population, mainly in summer holidays when it is in flower. It is just next to impossible to locate the *Delphinium* population in the location with human interference.

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