



DIVERSITY, ENDEMISM AND SOCIO-ECONOMIC VALUES OF THE INDIAN HIMALAYAN PAPAVERACEAE AND FUMARIACEAE

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Inventory of families Papaveraceae (6 genera, 36 species) and Fumariaceae (3 genera, 76 species) has been prepared. The species have been analyzed for species diversity, distribution pattern, nativity, endemism, similarity and affinity, socio-economic value and rarity. In Papaveraceae, *Meconopsis* (20 spp.), *Papaver* (10 spp.) and *Hypecoum* (4 spp.) are the dominant genera whereas in Fumariaceae, *Corydalis* (66 spp.) and *Dicentra* (7 spp.) are the dominant genera. Along an altitudinal gradient, maximum species have been distributed in between 3001-4500m zone, in both the families. Across the biogeographical provinces, diversity of the species is high in Trans, North West Himalaya and West Himalaya, in both the families. The proportion of native species is very high compared to non-native species. The number of endemic and near endemic species in Papaveraceae (endemic: 08; near endemic: 01) is very less compared to Fumariaceae (endemic: 18; near endemic: 42). Few species are represented in Nepal and Bhutan only, hence are endemic to these countries. The endemic diversity of the Indian Himalayan Papaveraceae and Fumariaceae has been compared with the endemic diversity of the neighboring countries/biogeographic domains. Indian Himalayan Papaveraceae shares maximum species with Nepal (IS = 73.68%; QA = 100%) and Pakistan (IS = 51.61%; QA = 66.67%) whereas Fumariaceae shares maximum species with Pakistan (IS = 56.36%; QA = 91.18%) and Nepal (IS = 52.17%; QA = 76.92%). Both the families are well known for medicinal and ornamental values. Among all the species, *Meconopsis aculeata* has been categorized as Endangered. The other endemic and near endemic species with restricted habitats, also fall under the threatened group of plants. The study identifies the altitudinal zone, 3001-4500m as priority site and, Trans, North West Himalaya as centre of endemic diversity for both the families. Selection of such sites for the assessment of diversity and distribution of species and conservation of rare and endemic species, have been suggested.

Key words: Diversity, nativity, endemism, socioeconomic, similarity, and affinity

The families Papaveraceae and Fumariaceae belong to the order Rhoeadales and the Indian

Himalayan species of these families are annuals and herbaceous perennials with milky and watery juice. Globally, the Papaveraceae represents 26 genera and about 200 species, distributed in the subtropical and temperate regions of the northern hemisphere with centres of distribution in North America and Central Asia and rarely distributed in Southern hemisphere. It includes mostly annual or perennial herbs except *Dendromecon* (shrub) and *Bocconia* (tree) (Hutchinson, 1973). *Hypecoum leptocarpum* has eastern range upto Japan and *Papaver nudicaule* into China, Mongolia and from Siberia to Europe (Dhar & Kachroo, 1983). In general the species of Papaveraceae prefer clayey, rocky slopes, weed infested places and semi-desert habitats.

The Fumariaceae comprises of about 17 genera and 465 species and distributed in warm temperate regions of the world and primarily in temperate Eurasia, some genera are distributed in South Africa and species of *Fumaria* in India (Hutchinson, 1973). In general the species of Fumariaceae prefer rocky slopes, water courses, agriculture and marginal lands.

The family Papaveraceae resembles with family Ranunculaceae in floral characters except syncarpous pistil of Papaveraceae, which forms a capsule at maturity, the distinct calyx and corolla, unilocular and syncarpous ovary with parietal placentation differentiates this family with Ranunculaceae. However, these characters put this

family closer to Brassicaceae and Capparidaceae (Hutchinson, 1973).

The systematic position of the family Fumariaceae is controversial. Some workers put this family as a sub-family under Papaveraceae and others recognize it as a separate family. The laterally zygomorphic corolla, distinctive androecium or two partite stamens and closed flowers established its status as a separate family under order Rhoadales (Hutchinson, 1973).

The studies on the flora of different biogeographic provinces of the Indian Himalaya have been conducted by various workers (Samant & Dhar, 1993). These studies also include the systematic description of genera and species of Papaveraceae and Fumariaceae. The information available on these families is fragmentary. Compilation of information and analysis for species diversity, distribution patterns along an altitudinal gradient and across biogeographic provinces, nativity, endemism, similarity and affinity within the Indian Himalayan biogeographic provinces and neighboring countries have not been carried out so far. Such studies are available only for few families (Dhar & Samant, 1993; Dhar *et al.*, 1996 & 1998), edible and medicinal plants (Samant & Dhar, 1997; Samant *et al.*, 1998a) and some protected areas (Samant *et al.*, 1998b) of the Indian Himalaya.

Keeping in view the conservation and socio-economic values of these families, the present attempt was made to: (i) study the species diversity along altitudinal gradient and across biogeographic provinces of Indian Himalaya; (ii) identify nativity, endemism, similarity and affinities of the families; and (iii) prioritize the sites and taxa for conservation and management.

MATERIALS AND METHODS

For data collection, analysis, and biogeographical classification of Indian Himalaya earlier studies (Dhar & Samant, 1993; Dhar *et al.*, 1996, 1998) were followed. The similarity in the floristic composition of different biogeographical provinces and neighboring countries has been calculated using Sorenson's (1948) Index of Similarity

(IS) which reads as: $IS = 2C / (A+B) \times 100$; where C = number of species common in two provinces/countries; A = number of species in province/country A; B = number of species in province/country B. Floristic affinity (Quotient of Affinity: QA) has been calculated following (Excell & Wild, 1961), which determines the degree of derivation of flora. This reads as $QA = C/S \times 100$; where C = Taxa common in a pair; S = Total taxa in smaller member of a pair.

Nativity of the species is based on the Anonymous (1883-1970) and Samant *et al.* (1998a). The endemism of the species was identified on the basis of distribution range. The species restricted to Indian Himalayan region has been identified as endemic and the species extending to neighboring countries such as Nepal, Bhutan, Tibet, Pakistan, and Afghanistan (Himalayan region) has been identified as near endemic. The Socio-economic values of the species are based on the primary and secondary information (Jain, 1991, Shah, 1996, Samant *et al.*, 1998a).

RESULTS

Species diversity

In the Indian Himalaya, Papaveraceae is represented by 6 genera and 38 species (Table 1). Among the genera the species richness is maximum in the genus *Meconopsis* (20 spp.), followed by *Papaver* (10 spp.) and *Hypecoum* (4 spp.). The genus *Argemone* represents 2 species and *Cathcartia* and *Dicranostigma* are monotypic genera of the family. The family is well represented in erstwhile USSR (158 spp.), Europe (40 spp.), Bhutan (19 spp.) and Pakistan (18 spp.).

The family Fumariaceae is represented by 3 genera and 76 species (Table 1). Genus *Corydalis* is the species rich (i.e., 66 spp.) among the three, followed by *Dicentra* (7 spp.) and *Fumaria* (3 spp.). Like Indian Himalaya, the family is well represented in erstwhile USSR (73 spp.) and Bhutan (50 spp.). Iran (41 spp.), Nepal (39 spp.), Pakistan (34 spp.) and Europe (27 spp.) are represented by comparatively less number of species.

Table 1. Species diversity and extent of endemism of the genera of Papaveraceae and Fumariaceae in Indian Himalaya and neighbouring countries

Table 1. Species diversity and extent of endemism of the genera of Papaveraceae and Fumariaceae in Indian Himalaya and neighbouring countries

	Indian Himalaya			Neighbouring countries					
	Total Taxa	Endemic (%)	Near Endemic (%)	Nepal Total taxa/ Endemic %	Bhutan Total taxa/ Endemic %	Pakistan Total taxa/ Endemic %	Iran Total taxa/ Endemic %	Europe Total taxa/ Endemic %	USSR Total taxa/ Endemic %
Papaveraceae									
<i>Papaver</i>	2	0.00	0.00	1/0.00	1/0.00	2/0.00	1/0.00	1/0.00	-
<i>Pulsatilla</i>	1	100	0.00	-	-	-	-	-	-
<i>Stigmaea</i>	1	0.00	100	1/0.00	1/0.00	-	-	-	-
<i>Thalictrum</i>	4	0.00	0.00	-	1/0.00	3/0.00	5/20	4/25	6/0.00
<i>Proteropis</i>	20	30	0.00	14/28.57	13/23.08	3/0.00	1/100	1/0.00	-
<i>Veratrum</i>	10	10	0.00	3/0.00	3/0.00	10/0.00	32/18.75	34/23.53	52/26.92
Fumariaceae									
<i>Delphinium</i>	66	25.75	57.58	34/20.59	45/17.78	32/6.25	33/45.45	26/42.31	61/31.15
<i>Thalictrum</i>	7	14.29	57.14	-	3/0.00	-	-	-	1/100
<i>Delphinium</i>	3	-	-	-	2/0.00	2/0.00	8/0.00	-	11/0.00

DISTRIBUTION PATTERNS

Biogeographical

Across biogeographic provinces, the species diversity is maximum in central (44 spp.), followed by Trans, North West (40 spp.), West (26 spp.) and East (21 spp.) Himalaya in family Fumariaceae. Similar distribution pattern across biogeographic provinces is shown by the family Papaveraceae i.e., maximum species diversity in Trans, North West and Central Himalaya (21 spp. each), followed by West (13 spp.) and East (12 spp.) Himalaya.

The family Papaveraceae is best represented in USSR (6 genera, 72 species), Iran (7 genera, 59 species) and Europe (8 genera, 46 species) compared to Indian Himalaya (6 genera, 38 species). On the contrary, the family Fumariaceae is best represented in Europe (7 genera, 80 species), Indian Himalaya (3 genera, 76 species), USSR (5 genera, 75 species) and Bhutan (3 genera, 50 species).

Altitudinal

The altitudinal distribution of species of families Papaveraceae and Fumariaceae is presented in Fig. 1 & 2. The maximum diversity exists in the zone 3001-4500m (i.e., 24 spp.), followed by 1501-3000 m zone (20 spp.). The remaining zones are relatively species poor zones (< 15 spp.). The family Fumariaceae also represents maximum diversity in the zone 3001-

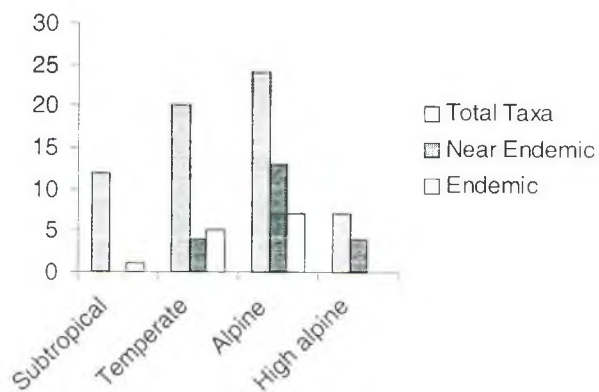


Fig.1. Altitudinal distribution of species of family Papaveraceae

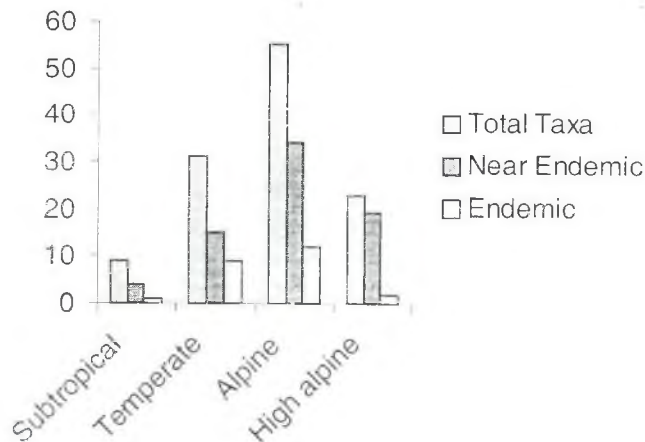


Fig.2. Altitudinal distribution of species of family Fumariaceae

4500m (55 spp.) and minimum in the sub-tropical zone (<1500m).

Nativity

Of the 38 species of family Papaveraceae, 25 species are native to Himalayan region and 13 species are non-natives largely represented in Mediterranean region, Arabia, Europe, Boreal America, Mexico, Soongaria, Graecia, Boreal Africa, Asia Minor, Persea and Arctic and Alpine regions (Fig. 3). All the species of *Meconopsis* are native to Himalayan region, whereas, genera *Hypecoum* and *Papaver* are represented by a single native species each. *Dicranostima*, a monotypic genus is native. The genus *Argemone* is represented by all the non-native taxa representing Mexico and Boreal America.



Fig. 3. Nativity of species of family Papaveraceae

The family Fumariaceae also represents high proportion of natives (71 spp.: 93.42%), compared to non-natives (5 spp.). Majority of the species of *Corydalis* and *Dicentra* are native to Himalayan region except *Corydalis adunca* Maxim. (native to China), *C. alpestris* Meyer (native to Boreal Asia, America), *C. longipes*, *C. rutaefolia* DC. and *C. sibirica* Pers. (native to both Himalayan region and other biogeographic domains) and *Dicentra paucinervia* Stern. (native to California). The genus *Fumaria* represents all non-natives (Fig. 4).

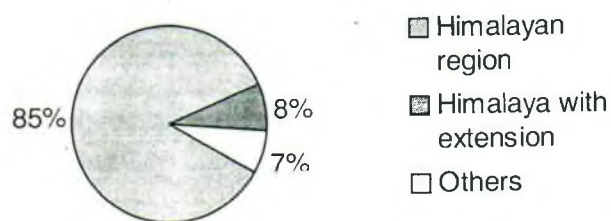


Fig. 4. Nativity of species of family Fumariaceae

Endemism

Endemism of a species indicates restriction of species in a particular biogeographic domain. In the present study, 8 species are endemic in Papaveraceae and one species is near endemic whereas in Fumariaceae 18 species are endemic and 42 species are near endemic. The list of endemic and near endemic species representing both the families is appended (Appendix I A-D). The species endemic to Nepal and Bhutan are also appended (Appendix I-B). Among the Indian Himalayan provinces, Trans, North West Himalaya comprises maximum endemic species in Papaveraceae (5) and Fumariaceae, (10), respectively.

Considering the Indian Himalaya and other Himalayan countries, the maximum endemic (>21%) are represented in India, Bhutan and Nepal whereas none of the endemic species are represented in Pakistan. Similarly, in Fumariaceae the number of endemic species is significantly high in Indian Himalaya (23.68%), Nepal (17.95%) and Bhutan (16%) compared to Pakistan (5.88%). Considering the Himalayan region as a geographical unit, the endemic percentage in Fumariaceae of Indian Himalaya increases to 78.95%.

In other biogeographic domains, endemism in Papaveraceae is almost similar (Iran: 20.34%; USSR: 20.83% and Europe: 19.57%) whereas in Fumariaceae endemism varies considerably (Iran: 38.10%, USSR: 28% and Europe: 27.50%).

Similarity and affinity

The similarity and affinity among the species of Papaveraceae and Fumariaceae across Indian Himalayan biogeographic provinces is presented (Table 2, 3 & 4). In Papaveraceae, the similarity is high between Trans, North West and Central Himalaya (IS= 57.14%), followed by Central and East Himalaya (IS=48%) whereas affinity is maximum between Central and East Himalaya (90.91%), followed by Trans, North West and West Himalaya (71.43%).

In Fumariaceae, Trans, North West and West Himalaya shared maximum number of species (IS=

Table 2: Similarity and affinity in the distribution patterns of family Papaveraceae within the biogeographic provinces of Indian Himalaya

Biogeographic provinces	T, NW IS/QA	W IS/QA	C IS/QA	E IS/QA
T, NW	100/100	57.14/71.43	24.39/25.00	25.00/36.36
W		100/100	41.18/50.00	48.00/54.55
C			100/100	32.26/90.91
E				100/100

Table 3: Similarity and affinity in the distribution patterns of family Fumariaceae within the biogeographic provinces of Indian Himalaya

Biogeographic Region	T, NW IS/QA	W IS/QA	C IS/QA	E IS/QA
T, NW	100/100	55.88/70.37	35.29/36.59	43.33/68.42
W		100/100	45.07/59.26	39.13/47.37
C			100/100	50.79/84.21
E				100/100

Table 4: Similarity and affinity in species composition with the neighboring Countries

Family	Nepal IS/QA (%)	Bhutan IS/QA (%)	Pakistan IS/QA (%)	Iran IS/QA (%)
Papaveraceae	73.68/100	38.60/57.89	51.61/66.67	22.68/28.95
Fumariaceae	52.17/76.92	50.70/64.00	56.36/91.18	11.86/16.67

Table 5. Socio-economic values of the families Papaveraceae and Fumariaceae (Sources: Jain 1991, Samant et al. 1998)

Family/Species	Parts/used	Indigenous uses
Papaveraceae		
<i>Meconopsis aculeata</i>	Whole plant	Backache, colic, renal pain, tonic
<i>M. grandis</i>	Leaf	Backache, renal pain
<i>Argemone mexicana</i>	Whole plant	Boil, ulcer, arthritis, asthma, earies, cough, dog bite, dropsy, eye complaints
<i>Papaver somniferum</i>	Latex	Gum trouble, headache
<i>P. dubium</i>	Flower	Inflammation, jaundice
<i>P. nudicaule</i>	Leaf, flower, seed	Leprosy, mouth wash,
<i>P. macrostomum</i>	Whole plant	Piles, ringworm, scabies, skin diseases, syphilis, tooth ache, whoop cough.
Fumariaceae		
<i>Corydalis flavellata</i>	Whole plant	Fever
<i>C. govatiiana</i>	Whole plant	Antipyretic, diuretic, eye diseases, gastric pain, liver complaints, muscular pain, skin diseases, syphilis, tonic, indigestion
<i>C. meifolia</i>	Whole plant	Headache, live and stomach pain, rheumatism, leprosy
<i>C. vaginans</i>	Sap	Eye diseases
<i>C. sibirica</i>	Whole plant	Antipyretic, diuretic
<i>Fumaria indica</i>	Whole plant	Anthelmintic, blood purifier, bodyache, diarrhoea, diuretic, fever, flue, indigestion, lever complaint, skin diseases

55.88%, QA+70.37%), followed by Central and East Himalaya (IS= 45.07%; QA=59.26%), respectively.

The Indian Himalayan Papaveraceae shares maximum species with Nepal (IS= 73.68%; QA= 100%) and Pakistan (IS=51.61%; QA= 66.67%) whereas Fumariaceae shares maximum species with Pakistan (IS = 56.36%; QA = 91.18%); Nepal (IS=52.17%; QA= 76.92%) and Bhutan (IS=50.79%; QA= 64%), respectively. Both the families showed less similarity and affinity with Iran (Papaveraceae: IS=22.68%; QA= 28.95%; Fumariaceae: IS=11.86; QA= 16.67%).

Rarity

Various attributes have been used to identify the rarity of the species in Indian Himalaya and other biogeographic provinces (Nayar & Sastry, 1987, 1988, 1990; Samant *et al.*, 1996; 1998a & b; Rawal & Dhar, 1997). Among the species, *Meconopsis aculeata* has been recorded under Endangered category (Samant & Pal, 2003). The restricted distribution of many species of both the families (Appendix I) also put them under the threatened group of plants. Such species need appropriate conservation and management measures.

Socio-economic value

The families Papaveraceae and Fumariaceae are known mainly for their medicinal and ornamental values. However, the stem of *Papaver somniferum* and leaves of *Fumaria indica* are cooked and used as vegetable. *Fumaria indica* is used in making cold drinks. The medicinal values of the species of both families are given in Table 5. Various chemical products are extracted from the species of *Papaver* (Morphine, Codeine and their salts narcotine, dionine, and papaverine); *Argemone mexicana* (Berberine and protopine); *Corydalis cornuta* (protopine, stylophine, l-aldumine, berberine, l-canedin, l-corypalmine, cryptocavine, a-allocryptopine, ophiocarpine and protopine) and *C. sibirica* (bicuculline, cheilanthifoline, corlumine, cryptopine, ochotensine, ochrobirine, protopine and scoulerine) (Anonymous, 1970-1988).

Opium is produced by the farmers of India on a large scale. The produce is outrightly purchased by the Government and sent to Government factories at Ghazipur (Uttar Pradesh) and Neemuch (Madhya Pradesh) for derivation of alkaloids and value added products. About 49.99 crores rupees were generated from the export of poppy heads, seeds, alkaloids, morphine, codein and their salts in the year 1994-1995 (Shah, 1996).

DISCUSSION

The richness and endemism of species plays vital role in identifying the priority areas and developing conservation programmes (Dhar &

Samant, 1993, Given, 1993). In the present study the families Papaveraceae and Fumariaceae are best represented in the zone 3001-4500 m and most species are native to Himalayan region. The species rich genera

Appendix I

A. Distribution of endemic Taxa in Indian Himalayan Provinces

Taxa	Altitude range (m)	Distribution
I. Papaveraceae		
<i>Cathcartia villosa</i> Hk.f. & Th.	3000-4000	E
<i>Meconopsis aculeata</i> Royle	3000-4500	TNW, W
<i>M. bikramii</i> Aswal	3300-3800	TNW
<i>M. betonicifolia</i> Franch.	3500-4500	E
<i>M. laifolia</i> (Prain) Prain	3000-3600	TNW
<i>M. neglecta</i> Taylor	3300-4000	TNW
<i>M. superba</i> King ex Prain	3000-3600	C
<i>Papaver stewartianum</i> Jafri & Quaiser	1000-2000	TNW
II. Fumariaceae		
<i>Corydalis adiantifolia</i> Hk.f. & Th. var. <i>heterocarpa</i> Jafri	3000-31000	TNW
<i>C. borii</i> Fischer	-	E
<i>C. bowerii</i> Hemsl.	-	W
<i>C. cavei</i> Long	2700-3400	C
<i>C. changensis</i> Long	3600-3900	C
<i>C. clarkei</i> Prain	3600-4500	TNW
<i>C. cornuta</i> Royle	2100-3200	TNW, W
<i>C. crithmifolia</i> Royle	3300-4500	TNW, W
<i>C. chaerophylla</i> DC. var. <i>geraniifolia</i> (Hk.f. & Th.) Hara	2400-3600	TNW
<i>C. denticulato bracteata</i> Fedde	4880	C
<i>C. duthiei</i> Maxim	3000-4000	TNW
<i>C. filicina</i> Prain	3000-4000	C
<i>C. meifolia</i> Wall. var. <i>violacea</i>	4200-4800	TNW
<i>C. murrenana</i> Jafri	2000	TNW
<i>C. ophiocarpa</i> Hk.f. & Th.	2700-3300	C
<i>C. vaginans</i> Royle	3300-4500	TNW
<i>C. stewartii</i> Fedde	3000-3300	TNW
<i>Dicentra ventii</i> Khunh	1500-2700	C

B. Himalayan endemic Taxa not reported in Indian Himalaya

Taxa	Altitude range (m)	Endemic
I. Papaveraceae		
<i>Meconopsis dhawajii</i> Tylor ex Hay	3500-4900	Nepal
<i>M. gracilipes</i> Taylor	3500-4900	Nepal
<i>M. regia</i> Taylor	3500-4600	Nepal
<i>M. taylorii</i> Williams	3600-4500	Nepal
<i>M. superba</i> Prain	2400-4100	Bhutan
<i>M. sherriffii</i> Taylor	4200-4600	Bhutan
<i>M. prunulina</i> Prain	3190-4600	Bhutan
II. Fumariaceae		
<i>Corydalis alburgii</i> Ludlow	5000	Nepal
<i>C. breviculcarata</i> Ludlow	3700	Nepal
<i>C. chasmophila</i> Ludlow	3960-4000	Nepal, Bhutan
<i>C. clavibracteata</i> Ludlow	3660-4700	Nepal
<i>C. megacalyx</i> Ludlow	3600-4500	Nepal
<i>C. pseudojuncea</i> Ludlow	3800-4400	Nepal
<i>C. staintonii</i> Ludlow	3800-4100	Nepal
<i>C. sykesii</i> Ludlow	4250	Nepal
<i>C. diphylla</i> Wall. var. <i>cyrtocentra</i> (Prain) Jafri	2200	Pakistan
<i>C. govaniana</i> Wall. var. <i>swatensis</i> (Kitam.) Jafri	3900	Pakistan
<i>C. eurosepala</i> Fedde	3500	Pakistan
<i>C. kingii</i> Prain		Bhutan
<i>C. dorjii</i> Long	1980-2500	Bhutan
<i>C. gerdae</i> Fedde	4400-4900	Bhutan
<i>C. alpestris</i> Meyer	4500-4700	Bhutan
<i>C. ovalifolia</i> Ludlow	4250-4570	Bhutan
<i>C. micronifera</i> Maxim	-	Bhutan
<i>C. laelia</i> Prain subsp. <i>bhutanica</i> Long	-	Bhutan
<i>C. lochanensis</i> Levcille	2500-3500	Bhutan
<i>C. crispa</i> Prain	3350-4570	Bhutan
<i>C. boweslyonii</i> Long	3800-4140	Bhutan
<i>C. calliantha</i> Long	3800-4730	Bhutan
<i>C. aurantiaca</i> Ludlow	4500-4700	Bhutan
<i>C. chasmophila</i> Ludlow	4400	Bhutan
<i>C. franchetiana</i> Prain	4260-4570	Bhutan

C. Distribution of near endemic taxa of family Papaveraceae in Indian Himalayan Provinces

Taxa	Altitude range (m)	Distribution
<i>Dicranostigma lactucoides</i> Hk. f. & Th.	3500-4000	W.C.E. Nepal, Bhutan
<i>Hyecoum leptocarpum</i> Hk. f. & Th.	2150-4200	T, NW, W, C. Bhutan
<i>Meconopsis auriculata</i> Stapf.	3500-4000	TNW, Nepal
<i>M. bella</i> Prain	3700-4600	C, Nepal, Bhutan
<i>M. concinna</i> Prain	4110	C, Nepal
<i>M. discigera</i> Prain	3300-4900	C, Nepal, Tibet
<i>M. gracilis</i> Taylor	3500-4900	C, Nepal
<i>M. grandis</i> Prain	3650-4200	C, E, Nepal, Bhutan
<i>M. paniculata</i> (Don) Prain	3300-4200	W.C.E. Nepal, Bhutan
<i>M. robusta</i> Hk.f. & Th.	3000-3800	TNW, W, Nepal
<i>M. simplicifolia</i> Hk.f. & Th.	3300-4600	C, E, Nepal, Bhutan, Tibet
<i>M. sinuata</i> Prain	2400-4400	C, Nepal, Bhutan
<i>M. villosa</i> (Hk.f.) Taylor	3200	C, Nepal, Bhutan
<i>Papaver dubium</i> L. var. <i>glabrum</i> (Royle) Koch	1900-2700	T, NW, W, C, E,

Nepal

Abbreviations used: TNW = Trans. North West; W = West; C = Central; E = East.

D. Distribution of near endemic of family Fumariaceae in Indian Himalayan Provinces

Taxa	Altitude range (m)	Distribution
<i>Corydalis cashmeriana</i> Royle	3300-5400	TNW, W, C, E, Nepal, Bhutan, Pakistan
<i>C. casimiriensis</i> Duthiei & Prain	2700-4500	TNW, W, C, E, Nepal, Bhutan
<i>C. chaerophylla</i> DC.	2000-4200	W, C, Bhutan
<i>C. cashmeriana</i> Royle subsp. <i>brevicornu</i> (Prain) Long	3000-3500	C, Bhutan
<i>C. crassissima</i> Camb.	3000-4500	TNW, Pakistan
<i>C. crassifolia</i> Royle	4000-5100	TNW, W, Tibet, Pakistan
<i>C. dubia</i> Prain	3900-4800	C, Bhutan
<i>C. drepanantha</i> Long	2000-2500	E, Bhutan
<i>C. cristata</i> (Prain) Long	3600-4800	C, Bhutan
<i>C. cristata</i> (Prain) Long, var. <i>longicalcarata</i>	3200-4500	C, Nepal, Bhutan
<i>C. elegans</i> Wall.	3600-4600	TNW, W, C, E, Nepal, Bhutan
<i>C. falconeri</i> Hk.f. & Th.	3300-4000	TNW, W, Tibet
<i>C. flabellata</i> Edgew.	2500-3600	TNW, W, Nepal, Tibet, Pakistan
<i>C. flaccida</i> Hk.f. & Th.	3300-5700	C, Nepal, Bhutan
<i>C. govaniana</i> Wall.	2400-4800	TNW, W, C, E, Nepal
<i>C. gerdae</i> Fedde	4500-5400	C, Nepal, Bhutan
<i>C. govaniana</i> Wall. var. <i>malukiana</i> Jafri	3900	TNW, Pakistan
<i>C. govaniana</i> Wall. var. <i>govaniana</i>	3300	TNW, Pakistan
<i>C. hendersonii</i> Hemsl.	5500	TNW, C, Nepal, Tibet
<i>C. juncea</i> Wall.	3600-4200	C, Nepal, Bhutan, Tibet
<i>C. laelia</i> Prain subsp. <i>laelia</i>	2700-4000	C, Bhutan
<i>C. laiflora</i> Hk.f. & Th.	4400-4900	C, E, Nepal, Bhutan
<i>C. leptocarpa</i> Hk. f. & Th.	1000-2800	C, E, Nepal, Bhutan
<i>C. lathyroides</i> Prain	3300-4100	W, C, Nepal, Bhutan
<i>C. meifolia</i> Wall.	4000-5700	TNW, W, C, E, Nepal, Bhutan
<i>C. meifolia</i> Wall. var. <i>sikkimensis</i> Prain	3900-5200	C, E, Nepal, Bhutan
<i>C. macrostigmata</i> Wall.	3000-5100	TNW, W, Tibet
<i>C. nana</i> Royle	4000-5000	TNW, W, C, Nepal
<i>C. oligantha</i> Ludlow	-	E, Bhutan
<i>C. polygalina</i> Hk. f. & Th.	3600-4900	C, Nepal, Bhutan
<i>C. pakistanica</i> Jafri	3500-4500	TNW, Pakistan
<i>C. pseudoerithmifolia</i> Jafri	4000	TNW, Pakistan, C, E, Nepal
<i>C. ramosa</i> Wall. ex Hk.f. & Th.	3600-4500	TNW, Bhutan
<i>C. sikkimensis</i> Prain var. <i>stracheyi</i>	4000-4600	C, Bhutan
<i>C. stracheyi</i> Prain var. <i>ecristata</i> Prain	3600-4600	C, Bhutan
<i>C. tibetica</i> Hk.f. & Th.	4000-5000	TNW, Tibet, Pakistan
<i>C. thysiflora</i> Prain	3500-5000	TNW, W, Tibet, Pak
<i>C. vaginans</i> Royle	2500-4500	TNW, Pakistan
<i>Dicentra macrocapnos</i> Prain	1500-2500	W, C, Nepal
<i>D. lichiangensis</i> Fedde	2400	C, E, Nepal

Meconopsis (20 spp.) and *Corydalis* (66 spp.) are also well represented in this zone. Like other families such as Ranunculaceae, Berberidaceae and Brassicaceae (Dhar & Samant, 1993, Dhar et al., 1996, 1998), the Papaveraceae and Fumariaceae also represent maximum endemic species in the zone 3001-4500m. The studies carried out in the Himalayan region

indicate that the endemic diversity increases with the increase in altitude (Dhar & Samant, 1993, Dhar *et al.*, 1996 & 1998). The present study also showed the similar patterns of endemism along altitudinal gradient. The richness, high nativity and endemism in the zone 3001-4,500m, distinguishes this zone as a priority site for conservation. The high percentage of endemic species in Trans, North West Himalaya in both the families suggests to this biogeographic province as a centre of endemic diversity. Selection of such sites for the assessment of diversity and distribution of these families is required for taking up appropriate conservation measures in selected site.

CONCLUSION

1. The present study provides a comprehensive inventory of families Papaveraceae and Fumariaceae of the Indian Himalaya and analyzes species for diversity, distribution patterns along altitudinal gradient and across biogeographic provinces, nativity, endemism, similarity and affinity within the Indian Himalayan biogeographic provinces and also, with the neighboring countries, socioeconomic values and rarity.
2. The altitude zone, 3001-4500m has been identified as a potential zone/site and Trans, North West Himalaya as a Centre of endemic diversity for both the families.
3. Assessment of species using standard ecological methods in the identified altitudinal zone, (3001-4500m) and centre of endemic diversity (Trans, North West Himalaya) is suggested so that the actual status of species in natural habitats could be identified for setting priorities for their conservation and management.

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