NOTE

Sikkim Himalayas – The Megadiversity Centre of *Pedicularis* L. in India

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ABSTRACT: Investigations on the Himalayan genus *Pedicularis* L. revealed rich concentration and enormous diversity of species in the Sikkim Himalayas. Out of the 83 Indian species of *Pedicularis*, 49 species (ca. 59%) are found in the Sikkim Himalayas and 34 species (ca. 41%) are endemic. The Sikkim Himalayas may therefore be designated as the 'megadiversity centre' of *Pedicularis* L. in India.

KEY WORDS: *Pedicularis*, Scrophulariaceae, Sikkim Himalayas, Endemic, Megadiversity centre.

INTRODUCTION

The Himalayan genus *Pedicularis* L. consists of eighty three species in India of which, 81 species are distributed in the Himalayan range, stretching from Ladakh in the west, through the Sikkim Himalayas, reaching up to Arunachal Pradesh in the east. Two species, namely *Pedicularis zeylanica* Benth. and *P. perottettii* Benth., are confined to the Nilgiri Hills of south India. The genus *Pedicularis* L. was first described by Linnaeus in 1737 and subsequently by many workers *viz*. Bunge (1846), Maximowicz (1882), Pennell (1943) and Prain (1889, 1890) and was recently revised (Husain and Garg, 2007). The generic name *Pedicularis* derives its origin from the Latin 'Pediculus' meaning louse, as its decoction was used against lice on domestic animals in some areas of central Europe. Hence, the members of this genus are commonly known as louse-worts. Many species exhibit such natural variations and extreme adaptations in their floral dynamics which indicate their adaptive response to survive and perpetuate in the drastic climatic conditions native to them (Garg and Husain, 2003). (Fig. 1, Table 1)

The genus *Pedicularis* on the whole is restricted to the temperate, sub-alpine and alpine-montane zones, but a few species such as *Pedicularis bifida*, *P. punctata*, *P. hoffmeisteri* descend to 2000 meters. Some species (*P. lachnoglossa* Hook.f., *P. bicornuta* Kl. ex Kl. and Garcke, *P. hoffmeisteri* Kl. ex Kl. and Garcke and *Pedicularis rhinanthoides* Schrenk ex Fisch. & C.A. Mey.) often reach the highest altitudes of above 5000 meters, the maximum height reached by flowering plants. However, the majority of the species occur at altitudes between 2500-4500 meters (Li, 1951) and rarely one or two species find their way towards the lowest extreme of 1000 meters (*Pedicularis khasiana* (Hook. f.) Pennell, *Pedicularis bifida* (Buch.– Ham. ex D. Don) Pennell).

Tsoong (1955a, b) reported the Sikang-Yunnan and the Sikkim regions to posses the highest concentration of *Pedicularis* species in the world. Yang Han-bi et al. (1998) concluded SW China to be the main center of diversity for *Pedicularis* species with about 352 species while few species occupy Bhutan (Mill, 2001). In India however, the maximum species concentration is found in the eastern Himalaya, especially in Sikkim extending in parts of China which projects in-between Sikkim and Bhutan. The number of species gradually decrease westwards. The species *P. punctata* Decne occupies most areas of the Kullu district extending from Kothi to Rohtang pass and further into the Lahaul and Spiti valley, whereas *Pedicularis bifida* (Buch. Ham. ex D. Don) Pennell occupies the entire Uttaranchal Himalayan regions. (Figs. 2 & 3)

The Sikkim Himalayas enjoy a position intermediate to the extreme climatic conditions of the eastern Himalayas on one hand and the western on the other. The eastern regions are endowed with uniformly moist stormy weather with frequent heavy rains, whereas the western zones are comparatively dry stormy and windy with ice-cold winds and frequent optimum rainfall. The magnitude of physical distance between the cold deserts of Ladakh and Lahaul-Spiti valley of western Himalaya and the Sikkim valley and the eastern Himalaya with a wide variety of ecological gradients induces variations among different species. The ideal location of the Sikkim Himalayas validate itself for species concentration and sustainence.

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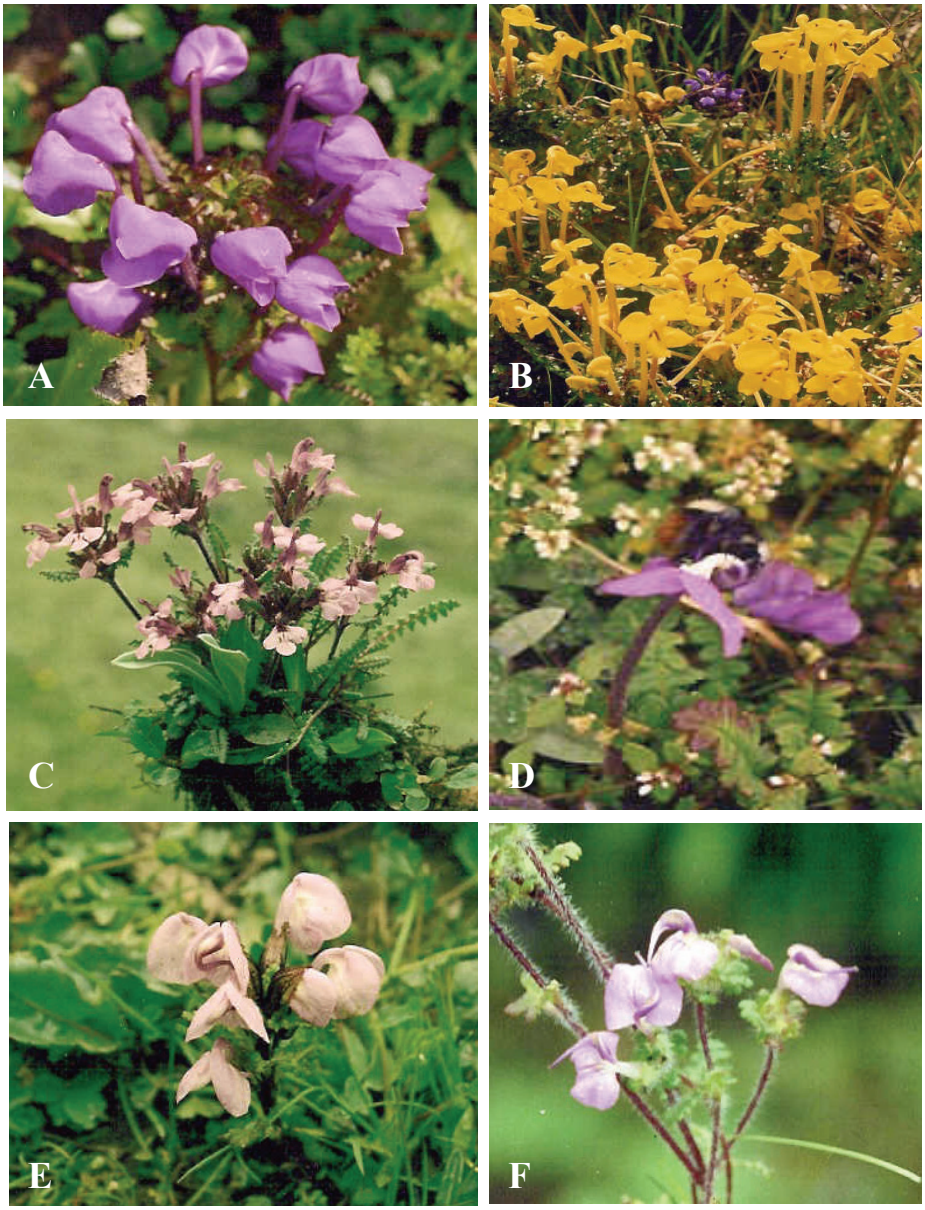


Fig. 1. Flower variation in species of *Pedicularis* occurring in Sikkim Himalayas. A: *P. megalantha* D. Don var. *megalantha.* B: *P. longiflora* Rudolf var. *tubiformis* (Klotzch) Tsoong. C: *P. roylei* Maxim. D: *P. siphonantha* D. Don. E: *P. rhinanthoides* Schrenk. ex Fisch. & Mey. subsp. *revoluta* Pennell. F: *P. porrecta* Wall. ex Benth.

MATERIAL AND METHODS

Field trips were made out to the Sikkim Himalayas during different flowering seasons to record the natural habitat, species occurrence and variations, ecological conditions, and microhabitat associations. All the collections were brought to laboratory, studied for the morphological variations among them and identified. Observations were recorded for plant morphology as related to diagnostic characters and morphological adaptations. The voucher specimens were deposited in the Herbarium (LWG) of the National Botanical Research Institute, Lucknow, where the studies were undertaken.

RESULTS AND DISCUSSION

The natural abode of the *Pedicularis* species are regions which are covered with snow for most of the year. As snow starts melting at the onset of July the sprouting of underlying dormant rhizomes begin. Flowering and fruiting commences within a short time and the entire life cycle is completed in a short span of two months, after which the

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Table 1. *Pedicularis* species occurring in the Sikkim Himalayas.

S. No.	Taxa	Distribution in India	Voucher specimen(s)
01*	*P. albiflora* (Hook.f.) Prain	Sikkim	Sikkim, Kankola, 13,000 ft., 22 Aug. 1879, *J.D.Hooker* s.n. (holo.: CAL!)
02*	*P. bella* Hook.f.	Sikkim	Sikkim,Darkia-la,5660m,Aug.,1892, *G.A. Gammie* s.n. (DD).
03	*P. bifida* (Buch.-Ham. ex D. Don) Pennell	H. P., Uttaranchal, Sikkim, Assam, Meghalaya, Manipur	Uttaranchal,Kumaon,Verinag,*Hira Lal* 1514 (LWG); Kumaon,1333 m, 21.8.1904, *N. Gill* 186 (LWG).
04*	*P. chumbica* Prain	Sikkim	Sikkim,Tanka-la, 5000 m, Aug., 1892, *G.A. Gammie* s.n. (DD); Seratong, 4500 m, 15.7. 1910, *W.W. Smith* 3474 (CAL).
05	*P. clarkii* Hook. f.	Sikkim, Nagaland	Sikkim,Changu, 4000 m, 26.10.1910, *Ribu & Rhomoo* 4371 (CAL, two specimens); Nagaland, Naga hills, June 1936, *N.L. Bor* 20758 (ASSAM).
06	*P. collata* Prain	Sikkim, Meghalaya, Manipur	Sikkim, Jongri, 4000 m, Oct. 1898, *s.l.* 11974 (CAL); Lanepokui, 4500 m, 12.8.1913, *G.H. Cave* 905 (CAL).
07*	*P. cooperi* Tsoong	Sikkim	Sikkim, Chola Pass, 16 Sept. 1913, *R.E. Cooper* 884 (holo.: Herb. Edinb.-*n.v.*).
08*	*P. confertiflora* Prain	Sikkim	Sikkim, Tanqa, 4300 m, 15.8.1909, *Smith & Cave* 2550 (CAL)
09	*P. curvipes* Hook. f.	Sikkim, Nagaland, Manipur	Sikkim, Tumbok, 10,000 ft, 9.10.1870, *C.B. Clarke* s.n. (CAL, fragmentary isotype in packet, mounted on sheet also bearing *Clarke* 41334B from Nagaland).
10*	*P. daltoni* Prain	Sikkim	Sikkim, Jankrata, 5340 m, August 1892, *G.A.Gammie* s.n. (BM).
11*	*P. denudata* Hook.f.	Sikkim	Sikkim Himalaya, Lachen Valley, 12-13,000 ft, *J.D. Hooker* numbered ' *Pedicularis* no. 11'-*n.v.*
12*	*P. diffusa* Prain	Sikkim	Sikkim, above Toong, 3340 m, 18.9.1913, *R.E.Cooper* 905 (BM); Zenum valley, 3330 m, 10.7.1909, *s.l.* 1147 (CAL)
13*	*P. elwesii* Hook.f.	Sikkim	Sikkim, Lachung valley, Aug., 1892, *G.A. Gammie* s.n. (DD).
14*	*P. excelsa* Hook.f.	Sikkim	Sikkim, Yeumtong, 12, 000 ft, Sept. 1849, *J.D. Hooker* & *Thomson Pedicularis* no.27 (holo.: K-*n.v.*; iso.: BM!).
15*	*P. exigua* Li	Sikkim	Sikkim, Thangu, Sept. 1903, *Prain s.n.* (holo.: Univ. of California-*n.v.*; iso.: PH-*n.v.*).
16	*P. flagellaris* Benth.	Sikkim, Meghalaya	Meghalaya, K.&J. Hills, Laitlyngkot, 11.8.1938, *R.N. De* 16851 (ASSAM).
17*	*P. flexuosa* Hook.f.	Sikkim	Sikkim,Changu,4000 m, 2. 07.1913, *R.E. Cooper* 126 (BM); Kapup, 4340 m, 7.7.1913, *R.E. Cooper* 173 (BM)
18	*P. furfuracea* Wall.	West Bengal, Sikkim	Sikkim,June,1887, *King* s.n. (BM); Phusum, 3330 m, 25.6.1945, *Bor & Kirat Ram* 20586 (DD)
19*	*P. gammieana* Prain	Sikkim	Type: Sikkim,'Eastern Himalaya, Lang-mang-nang-zo,10,000ft, Pantling' (iso.: K-*n.v.*).
20	*P. gibbera* Prain	Sikkim, Arunachal Pradesh	Sikkim, Sept., 1887, *Dr. King's Collector s.n.* (DD); Sukki-moral, W. Tangui, Aug., 1887, *Dr. King's collector s.n.* (DD, CAL).
21*	*P. globifera* Hook.f.	Sikkim	Type: Sikkim Himalaya,Kongra Lama, 14-15,000ft, *J.D.Hooker* numbered '*Pedicularis* no. 10'-*n.v*
22a	*P. gracilis* Wall. subsp. *gracilis* var. *gracilis*	Kashmir to Sikkim, & Assam	Jammu & Kashmir, Bhadrawaha-Sevj, 2800 m, Aug. 1986, *J.N. Vohra & B.D. Naithani* 83032 (BSD). Himachal Pradesh, Manali, 2800 m, 13.8.1941, *N.L. Bor* 15326 (DD); Arunachal Pradesh, Bomdi la-Saleri, 2000 m, 19.10.1955, *Rankin & Pretzlik* 056 (BM).
22b	var. *stricta* (Wall.ex Prain) Husain & Garg	Kashmir to Sikkim	Uttaranchal,Kumaon, way to Ralam Glacier, 4000-4500 m, 15.9.1969, *Pant & Naithani* 39686 (BSD). Sikkim, 2000 m, *R.H.Beddome* 5752 (BM).
22c	Subsp. *brunoniana* (Wall. ex Pennell) Husain & Garg var. *brunoniana*	Himanchal Pradesh to Sikkim &, Nagaland	Himachal Pradesh, Moralkanda, 3000 m, 29.9.1970, *P.C.Sharma & D.P.Badola* 880 (LWG); Sikkim, Tangloo, 2700-3300 m, 3.8.1862, *T. Anderson* 992 (DD)
22d	var. *macrocarpa* (Prain) Tsoong	Kashmir to Sikkim	Jammu & Kashmir, near Bhairon temple, 31.8.1989, *B.P. Uniyal* 77404 (BSD); Uttaranchal, Kumaon, Loharkhet, 2000-3220 m, 20.9.1957, *T.A. Rao* 4244 (BSD),Changu, 4333 m, 9.9.1913, *R.E. Cooper* 847 (BM).
23*	*P. garckeana* Prain ex Maxim.	Sikkim	Specimens from Chumbi and Phari are housed in DD (details not available)
24*	*P. instar* Prain ex Maxim.	Sikkim	Sikkim, Lachung valley, 5000 m, 15.8.1892, *G.A. Gammie* 789 (CAL).
25*	*P. integrifolia* Hook.f.	Sikkim	Type: Sikkim Himalaya, Tungu, 12-14,000 ft, *J.D. Hooker* numbered '*Pedicularis* no. 8'-*n.v.*
26*	*P. kingii* Prain ex Maxim.	Sikkim	Sikkim, Poshing La, 4000 m, 21.7.1938, *Kingdon-Ward* 13952 (BM).
27*	*P. lachnoglossa* Hook.f.	Sikkim	Type: Sikkim,Lachen valley, 14,000 ft, 15.7.1849, *J.D. Hooker* numbered '*Pedicularis* no. 32' (lecto.: K-*n.v.*-specimen with handwritten ticket; isolecto.: BM-*n.v.*).
28	*P. longiflora* Rudolf var. *tubiformis* (Klotzch) Tsoong	Jammu & Kashmir, Himanchal Pradesh, Uttaranchal, Sikkim, Arunachal Pradesh, Assam	Jammu & Kashmir, Ladakh: above Tsakzhum Tso,5830 m,23.7.1931, *Walter Koelz* 2415c (DD). Uttaranchal, Kumaon,Gori valley,Parbhu,12.8.1900, *Inayat* 24799 (DD); North Sikkim: Thangu to Lachen, 3200 m, 6.10.1997, *P. Singh & S.S. Dash* 20065 (BSHC).

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Table 1. Continued.

S. No.	Taxa	Distribution in India	Voucher specimen(s)
29	*P. megalantha* D. Don var. *megalantha*	Sikkim, Uttaranchal	Uttaranchal, Garhwal, Tehri Garhwal, Rhudughera, 3670-4000 m, 19.7.1883, *J.F.Duthie* 237 (DD). Sikkim, Changu & Kapup, 4000-4333 m, 19.8.1913, *R.E. Cooper* 551 (BM).
30*	*P. megalantha* D.Don var. *pauciflora* Prain ex Maxim.	Sikkim	Type: Bloktan (Bhutan), near Tashi (Tagi), July, 1887, *Dr. King's collector s.n.* (holo.: CAL!; iso.: DD!). There is one more specimen of Dr. King's collector from Chumbi in CAL, of var. *pauciflora* collected in Oct. 1884.
31*	*P. microcalyx* Hook.f.	Sikkim	Sikkim, Kapup, 4340 m, 8.7.1913, *R.E.Cooper* 176 (BM); Patung lu, 17.7.1877, *G. King* 4395 (DD)
32	*P. mollis* Wall	Jammu &, Kashmir, Himanchal Pradesh, Uttaranchal, Sikkim	Jammu & Kashmir, Ladakh, Shyok, 4200m,29.8.1975,*M.V.Vishwanathan* 55042(BSD).Uttaranchal, Kumaon, Byans, Palang Gadh, 3330-3660 m, 19.7.1886, *J.F. Duthie* 5844 (DD); Sikkim, 3300-4600 m, *Hooker* s.n. (BM).
33*	*P. nepalensis* Prain	Sikkim	Sikkim, Choon-goo, Sept. 1882, *Dr. King's Collector* s.n. (CAL).
34*	*P. odontophora* Prain	Sikkim	Sikkim, at Na-tong, 24.8.1878, *Dungboo* s.n. (DD, CAL).
35*	*P. oederi* Vahl subsp. brachiophylla (Pennell) Tsoong	Sikkim	Type: Sikkim, 16000 ft., 22.7.1909, *Smith & Cave* 1714 (holo.: PH-*n.v.*, iso.: CAL!)
36*	*P. pantlingii* Prain	Sikkim	Sikkim, Ling-too, 4000m, 2.9.1882, *King's collector* s.n. (BM).
37*	*P. polygaloides* Hook.f.	Sikkim	Sikkim, Jang-ka-la, 14.8.1882, *G. King's Collector* s.n. (DD).
38	*P. porrecta* Wall.	Kashmir, Himanchal Pradesh, Uttaranchal, Sikkim	Uttaranchal, Kumaon, Ralam valley, 16.8.1900, *Inayat* 24786 (DD); Ralam valley, 4500-5000 m, 24.8. 1884, *J.F. Duthie* 3226 (DD)
39*	*P. Prainiana* Maxim.	Sikkim	Type: China, Chumbi, Lu-ma-poo, 20.7.1884, *Dr. King's collector* 509 (CAL!).
40*	*P. regeliana* Prain	Sikkim	Type: Sikkim, Jongri, 12,000 ft., Sept.1887, *Dr. King's Collector* s.n. (lecto.:CAL!; isolecto.: BM!). Other original syntypes: Jongri, Tha-moo-tsa, 12000 ft., Aug. 1887, *Dr. King's Collector* s.n. (CAL!, BM!).
41*	*P. rhinanthoides* Schreb ex Fisch. & C.A.Mey. subsp. *revolute* Pennell	Sikkim	Type: Sikkim, Llonok, Naku Chu, 5000-5500 m, 3 Aug. 1909, *Smith & Cave* 1945 (holo.: PH-*n.v.*; iso.: CAL!).
42*	*P. robusta* Hook.f.	Sikkim	Sikkim, Samdong, 5600 m, 17.8.1892, *G.A.Gammie* 873 (CAL).
43	*P. roylei* Maxim.	Jammu &, Kashmir, Himanchal Pradesh, Uttaranchal, Sikkim	Jammu & Kashmir, Chovsar, 17.7.1899, *Inayat* s.n. (DD); Sikkim, North Sikkim, Yum Thang (Hot water spring area), 19.7.1987, *D.C.S. Raju & S. Singh* 7733 (BSHC);
44*	*P. schizorrhyncha* Prain*	Sikkim	Sikkim, Kankerteng, 4300 m, 09.1888, *Dr. King's Collector* s.n. (BM, DD).
45*	*P. scullyana* Prain ex Maxim.*	Sikkim	Sikkim, Bijan, Dact Lefal, 3670 m, 09.1888, *Dr. King's collector* s.n. (BM, DD); Damkerka, Lefal forest, 4000m, 09.1888, *Dr. King's collector* s.n. (BM).
46	*P. siphonantha* D.Don - Fig. 1D	Jammu &, Kashmir, Himanchal Pradesh, Uttaranchal, Sikkim, Arunachal Pradesh, Assam	Jammu & Kashmir, Gulmarg: 3333 – 3700 m , 8.1922 , *J.H.Barbour* s.n. (BM); Uttaranchal, Garhwal, Pangu, *Stocliczka* 3 (BM).
47*	*P. sikkimensis* Bonati, W.W.Smith	Sikkim	Sikkim, Zeumn valley, 3900 m, 11.7.1909, *Smith & Cave* 1213 (CAL).
48*	*P. tenuicaulis* Prain	Sikkim	Sikkim, Guatung, Aug. 1891, *Dr. Camnivas* s.n. (CAL).
49	*P. trichoglossa* Hook.f.	Sikkim, Uttaranchal	Uttaranchal, Kumaon, Dhauli valley near Raina, 4000-4330m, 3.9.1884, *J.F.Duthie* 3222 (BM, DD); Sikkim, 4000-5000m, *J.D.Hooker* 29 (BM).

Note: Asterisk (*) indicate the species endemic to Sikkim

area is again covered by a thick blanket of snow towards the end of September. Boggic soil conditions are most suitable for the growth of *Pedicularis* but many species frequently occur in streams and nullahs.

A high degree of microhabitat-specific character was observed within the different species of *Pedicularis* with 4-5 plant species, predominantly of Legumes and some Graminae, Cyperaceae, Rosaceae, Ranunculaceae, Polygonaceae etc. constituting the micro-environment of any one species of *Pedicularis*, each one being specific to their hosts. Further, the roots were intricately entangled with those of the associated species and formed gregarious patches. The flowers of *Pedicularis* were strikingly delicate and brightly coulourful (Fig. 1) and appeared exceptionally prone to perish in the drastic climatic conditions, but species survival perpetuates due to their amazingly adaptive strategies (Garg and Husain, 2003).

The field studies followed by identification in lab and comparative morphological analysis confirmed the existence of 83 species in India with many infra-specific taxa (Husain and Garg, 2007). Out of the existing 83

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Fig. 2. Distribution of *Pedicularis* species in India.

Indian species, 81 species find their place on high altitudes of the Himalayan ranges of India and two species, namely *Pedicularis zeylanica and P. perrottetii,* are confined to the Nilgiri hills of southern India. The Eastern Himalayas were endowed with an admixture of 44 species, most of them occurring in the Sikkim Himalayas from where they proliferate in all directions, and generally appear as heterogenous assemblage. The number of species gradually decrease westwards and become restricted to 26 species in the Western Himalayas, where they normally form homogenous population patches. There were as many as 11 species which were common to the east and west Himalayan zones (Fig. 3). Most of these were represented in Sikkim (Table 1). A complete list of species that are found in the Sikkim Himalayas, including those endemic to Sikkim, is provided in Table 1. An outstanding amalgam of 49 species (ca. 59%) existed in Sikkim, of which 34 species (41%) were strictly endemic. The maximum species diversity and concentration (49 species) coupled with noticeable endemism (34 species) was found in Sikkim. Due to the strikingly diverse assemblage and rich endemism, the Sikkim Himalayas may be proposed as the 'megadiversity centre' of Indian *Pedicularis*.

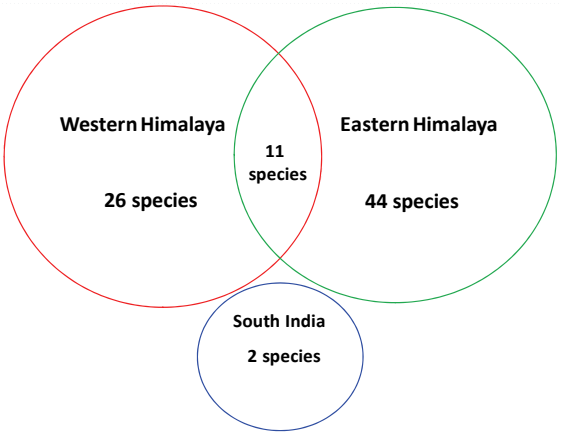


Fig. 3. Statistical representation of Distribution of *Pedicularis* species in India.

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錫金喜馬拉雅地區—馬先蒿屬植物在印度之超級多樣性中心

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摘要：在喜馬拉雅地區馬先蒿屬植物的調查中，顯示本屬植物在錫金喜馬拉雅地區物種相當豐富密集而且具有極高的物種多樣性。印度之 83 種馬先蒿屬植物中，在錫金喜馬拉雅地區就有 49 種(約占 59%)，而且其中 34 種(約占 41%)為本地區之特有種。因此我們可以說錫金喜馬拉雅地區是馬先蒿屬植物在印度之超級多樣性中心。

關鍵詞：馬先蒿屬、玄參科、錫金喜馬拉雅地區、特有的(種)、超級多樣性中心。

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