

Eco-Taxonomical Investigation of a Fern Genus *Huperzia* from Central Himalayan Glaciers of India

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Abstract: The present eco-taxonomic work is based on the detailed and careful collections of a Pteridophytic flora (*Huperzia* spp.) of the Pindari and adjacent glaciers from Indian Central Himalayas. The period of study was from year 2005 to 2009 between the altitudes, stretching from 800-2,356 m, throughout the years, particularly during rainy season, when almost all pteridophytes show abundant and luxuriant growth and development. The method of collections, pressing, poisoning and mounting was carried out thoroughly. Taxonomic treatment includes an artificial key to the identification of families, genera and species.

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1. Introduction:

The Himalaya is floristically the richest and most varied phyto-geographical region of the Indian subcontinent and as a result of its suitable climate combined with its position as a migration-route, nearly three quarters of the ferns and fern-allies of the India are found there. Pteridophytes are the second largest component of the Himalayan flora (after Angiosperms) and are also a major component of the area's biomass. They also effectively contribute to ecosystem's productivity and resilience. Their graceful luxuriance and vigorous growth, particularly visible during the rainy season, in every possible habitat, including on trees, boulders, walls, rocks and rock-crevices, in deep ravines, forested and open places and dry and aquatic environments, contributes significantly towards enhancing the beauty of the Himalayan landscape.

Kumaun Himalaya harbors a rich and varied flora including Pteridophytes. This region is in fact a transitional zone between dry western Himalaya and wet eastern Himalaya. Here many western Himalayan and eastern Himalayan floral elements show their eastward and westward limits of distribution, showing a great degree of mixture of both eastern

Himalayan and western Himalayan floral elements. In spite of such a varied and rich flora including pteridophytes, no serious attempt has been made to describe the Pteridophytic flora of the region in comprehensive manner. The survey of earlier published literature related to the Pteridophytic flora of Kumaun Himalaya (1,2,3,4,5,6,7,8,9,10,11,12,13 and others). We have made a comprehensive eco-taxonomic study of Pteridophytic flora from Kumaun Himalayan glaciers and their adjoining areas.

2. Study Area:

The study area lies in the interior Himalayan zone in the western sections of the Greater Himalaya and is situated between latitudes of 30° 5'-30° 10' North and longitudes of 79° 46'-80° 14' E with the high ridge containing trail Pass (5300 m) north of Pindari glacier and further south-eastwards the Nandakot range (6843 m) and Lampa Dhura (6034 m), acting as a water divide and orographic and hydrographic of a vast area. The area serves as a huge reserve of high land snow thus making up a source of well known glaciers of Kumaun (Uttarakhand) i.e. Pindari, Kaphni and Sundardhun.

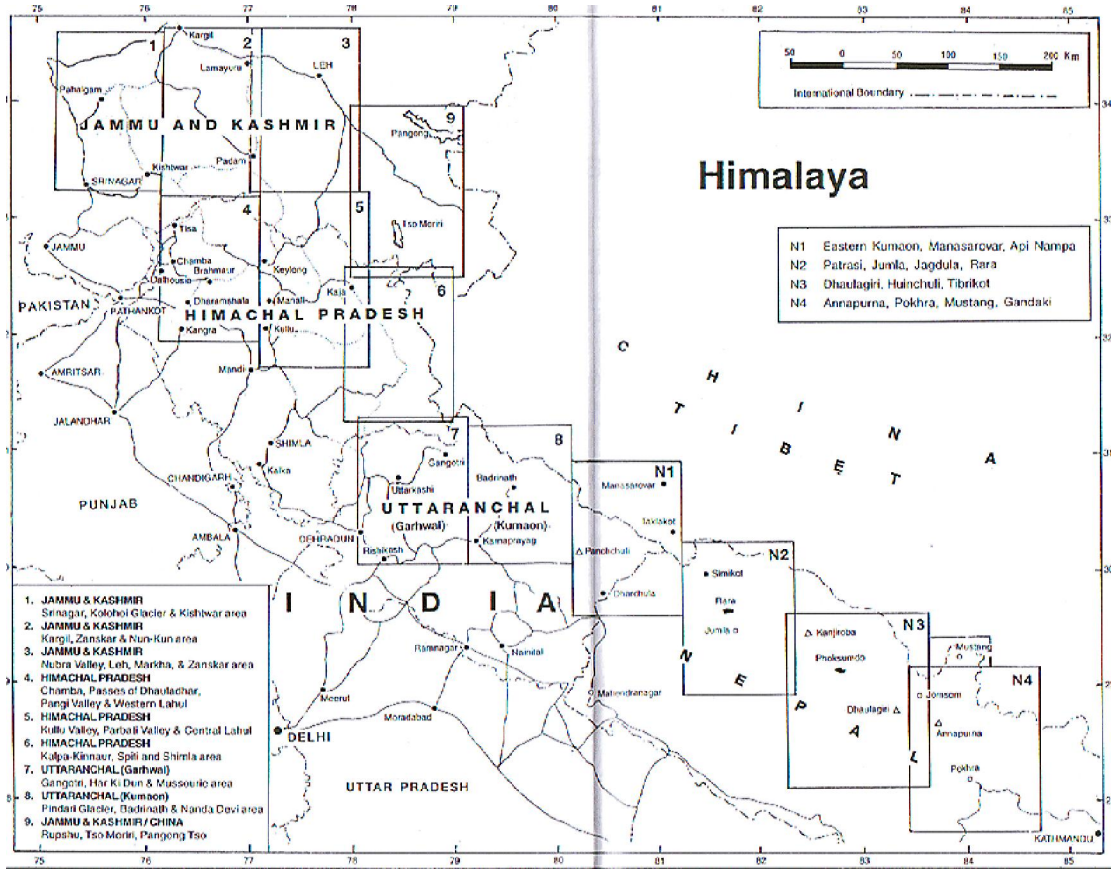


Fig 1. Uttarakhand (Previously known as Uttaranchal) State and Indian Central Himalaya (Source: mapsworldwide.com)



Fig 2. Study Sites: Pindari and Kafni Glaciers in Kumaon Region of Uttarakhand State (India) (Source: www.himadventures.net)

3. Material and Methods:

The collections of *Huperzia spp.* ferns were made throughout the years especially during the rainy season, when most of the pteridophytes grow in

abundance on different habitats. During the collection period in the fields, elaborate notes particularly on the types of their habitats, size of fronds, nature of rhizome, color of scales, if present, and indusia wherever present were made in the field note book. The collection, pressing, pretreatment and preparation of herbarium specimens were made according to the recommended procedures (14). At the end of collections, their identification was made with the help of available floras, monographs and other relevant research papers. The species were confirmed by matching the specimens in the Herbaria of Botanical Survey of India (North Circle), Dehra Dun (BSD), Forest Research Institute & Colleges, Dehra Dun (DD), Department of Botany, Punjab University, Chandigarh (PAN).

Family: **LYCOPODIACEAE** P.Beauv. *ex* Mirb.

In Lam. & Mirb., *Hist. Nat. Veg.* 4: 293 (1802).

KEY TO GENERA

A. A distinct strobilus not formed.....1.

Huperzia

A. Distinct strobili formed.....2.

Lycopodium

HUPERZIA Bernh.in Schrad., J. Bot. 1800(2): 126 (1802).

4. Description of Genus *Huperzia*:

The Plants of genus *Huperzia* are terrestrial or epiphytic in nature. Rooting is present only at the base. Stem is generally erected to sub-erect or sometimes pendulous also. Branching is isodichotomous type; the branches are usually ascending, symmetrical, and rarely simple. The Leaves and Sporophylls are isomorphous or heteromorphous type. Strobilus or cones are not formed at all in this genus. Occasional vegetative reproduction may occur by bulbils in *Huperzia* spp. The Stele is typical actinostelar or plectostelar type. Sporangia are positioned in the axils of unaltered leaves all down the stem or branches, or aggregated in terminal strobili. The reproductive spores of *Huperzia* are trilete.



Fig 3. *Huperzia selago*



Fig 4. *Huperzia hamiltonii* (Spreng.)

5. Key to Four Different Species of Genus *Huperzia*:

- A. Plants terrestrial, bearing proliferous buds..... (3). **H. selago**
 A. Plants epiphytic, on mossy rocks or on tree-roots, without budsB
 B. Aerial stem 5-6 times forked, leaves linear..... (2). **H. petiolata**
 B. Aerial stem simple to 2-3 times forked, leaves lanceolate to broad.....C
 C. Aerial stem simple to once forked, leaves lanceolate..... (3). **H. pulcherrima**
 C. Aerial stem 2 -3 times forked, leaves ovate-lanceolate (1). **H. hamiltonii**

(1) ***Huperzia hamiltonii*** (Spreng.) Trevis., Atti. Soc. Ital. Sci. Nat. 17: 248 (1875); T. & U. Sen, Fern Gaz. 11(6):419(1978); Dixit, Census Indian Pterid.:7 (1984); Lycopodaceae India: 48 (1988); Punetha *et al.* in Gupta, Higher Pl. Indian Subcont. 2(5): 128 (1991); Fraser-Jenkins, New Sp. Syndr. Indian Pterid. & Ferns Nepal: 147-8 (1997)

= *Lycopodium hamiltonii* Spreng. in L., Syst. Veg. Linn. ed. 16, 5: 429 (Index) (1828); Grev. & Hook. in Hooker Bot. Misc. 2: 366 (1831); Spring, Mém. Acad. Sci. Brux. 15 (1): 25 (1842); 24(2): 17 (1850); Clarke, Trans. Linn. Soc. Lond. II (Bot.) 1: 590 (1880); Baker, Handb. Fern-allies: 10 (1887); Mandal & Sen, Biol. Mem. 3: 219 (1979); Pant & Pandey, Phyta Monogr. 3: 9 (1985); Rao, Bull. Bot. Surv. India 2: 92 (1960); Pangtey & Punetha, in Pangtey & Joshi, Western Him. 1: 390 (1987).

= *Urostachys hamiltonii* (Spreng.) Herter *ex* Nessel, Die Bärlappgew.: 68 (1939).

= *Phlegmariurus hamiltonii* (Spreng.) Å. & D.Löve, Taxon 26: 326 (1977).

= *Lycopodium obtusifolium* D. Don, Prodr. Fl. Nepal.: 18 (1824), *non* Sw. (1801).

Description of *Huperzia hamiltonii*: The plants are epiphytic pendent and tufted. Roots are present only near the proximal part of the plant. Stem is 13-25 cm long, 1-2 mm in diameter, terete, 2-3 times dichotomously branched and the stele is Plectostelar. The Leaves are equal, or sometimes of two sizes, sub-petiolate, moderately crowded, thick, stiff, glossy, ovate-lanceolate, varying to slightly more lanceolate, subacute and entire. The large leaves measure 10-13 x 4-5 mm; small leaves 3.0-5.0 x 1.5-2.0 mm, the latter are generally in the distal region of plant, where they are intermixed with large ones and veins are faintly raised on both surfaces. Sporophylls are similar to sterile leaves, fertile leaves generally aggregated in the distal region, present throughout except the basal region. Sporangia are large, reniform and stalked. The stalk is 6-7 cells long, 3-4 cells broad. The spores of *Huperzia hamiltonii* are brown in colour.

Ecology of *Huperzia hamiltonii*: The plants grow both lithophytically and, more usually, epiphytically, between 1400 and 2500 m altitude. They are infrequent but common to abundant locally in Kumaun between Loharkhet and Dhakuri; Loharkhet, Khati, Jhuni; Madhari.

Distribution of *Huperzia hamiltonii* : This Heterosporous Pteridophytic species is found distributed over a large geographical area across Indian Himalayan States like Sikkim; Darjeeling; Assam; Arunachal Pradesh; Meghalaya; and some parts of Bihar and Orissa. The species also shows its strong appearance in parts of Nepal; Bhutan; Myanma (Burma); Southern China; Taiwan; Southern Japan; Thailand and Vietnam.

(2) *Huperzia petiolata* (C.B.Clarke) R.D.Dixit, J. Bombay Nat. Hist. Soc. 77(3): 541 (1981); Dixit, Census Indian Pterid.: 8 (1984); Lycopodaceae India: 50 (1988).

= *Lycopodium hamiltonii* Spreng. var. *petiolata* C.B.Clarke, Trans. Linn. Soc. Lond., II (Bot.) 1: 590 (1880).

= *Lycopodium petiolatum* (C.B.Clarke) Herter, Bot. Jahrb. 43: 36 (1909).

= *Phlegmariurus hamiltonii* (Spreng.) Å. & D.Löve var. *petiolata* (C.B. Clarke) Ching, Act. Bot. Yunnanica 4(2): 126 (1982).

= *Huperzia subulifolia* (Wall. ex Hook. & Grev.) Trevis. var. *assamica* Mandal & U.Sen, Biol. Mem. 3(2): 225 (1979).

Description of *Huperzia petiolata*: Plants are terrestrial or commonly found on the roots or near bases of tree-trunks, sometimes epiphytic on lower branches, commonly erect, or becoming pendent, single stems or slightly branched. Roots are present only at the base. Stem usually to 15 cm tall, terete, simple to once or sometimes twice branched, seldom more, stele plectostelar. Leaves equal in size, petiolate, slightly distant, thin, smooth, lanceolate to rather narrowly lanceolate, patent to sub-patent, slightly obtuse at the apex and narrowly cuneate at their bases, 10-12 x 1.5-2 mm, midrib clearly visible on both surfaces. Sporophylls similar to sterile leaves, fertile leaves generally present throughout, sometimes including the basal region. Sporangia large, reniform, stalked, stalk 6-7 cells long, 3-4 cells broad. Spores brown.

Ecology of *Huperzia petiolata*: This species grows epiphytically, usually near the bases of tree-trunks, or on tree-roots, or occasionally on moss-covered rocks, around 2000 m altitude. Since it is rare, so sometimes can easily be overlooked as unrecognized. The species of *Huperzia petiolata* often occurs together with the previous species i.e. *Huperzia hamiltonii* in Loharkhet to Khati, 2000-3200 m (*T.A. Rao* 4272, 20 Sept. 1957 (BSD)).

Distribution of *Huperzia petiolata*: India (Sikkim; Darjeeling; Meghalaya; Arunachal Pradesh; Manipur); Nepal; Bhutan; Tibet; China.

(3) *Huperzia pulcherrima* (Wall. ex Hook. & Grev.) Pic.Serm., Webbia 24: 719 (1970); Sen & Sen, Fern Gaz. 11(6): 419 (1978); Dixit, Census Indian Pterid.: 8 (1984); Lycopodaceae India: 60 (1988); Pande & Pande, Indian Fern J. 5: 151 (1988); Punetha & Kholia, New Botanist 16: 116 (1989); Pangtey & Samant, J. Bombay Nat. Hist. Soc. 90: 122 (1989); Pande, Indian Fern J. 7: 59 (1990); Punetha *et al.*, in Gupta, Higher Pl. Indian Subcont. 2 (5): 127 (1991); Fraser-Jenkins, New Sp. Syndr. Indian Pterid. & Ferns Nepal: 147-8 (1997).

= *Lycopodium pulcherrimum* Wall. ex Hook. & Grev., Icon. Fil.: t. 38 (1827); Mandal & Sen, Biol. Mem. 3: 215 (1979); Pant & Pandey, Phyta Monogr. 3: 9 (1985); Singh *et al.*, Indian J. For. 9: 4 (1986).

= *Urostachys pulcherrimus* (Wall. ex Hook. & Grev.) Herter, Index Lycopod.: 77 (1949).

= *Phlegmariurus pulcherrimus* (Wall. ex Hook. & Grev.) Å. & D.Löve, Taxon 26: 324 (1977).

= *Lycopodium setaceum* D.Don, Prodr. Fl. Nepal.: 18 (1824), *non* Lam. (1789); C.B.Clarke, Trans. Linn. Soc. Lond. II (Bot.) 1: 590 (1880); Trivedi *et al.*, J. Indian Bot. Soc. 62: 91 (1983); Pangtey & Punetha in Pangtey & Joshi, Western Him. 1: 390 (1987).

= *Urostachys setaceus* (D.Don) Herter, in Engler Bot. Jahresb. 43: 35 (1909).

= *Huperzia subulifolia* (Wall. ex Hook. & Grev.) Trevis., Atti Soc. Ital. Sci. Nat. 17: 248 (1875); T. & U. Sen, Fern Gaz. 11: 413-427 (1978); Mandal & U. Sen, Biol. Mem. 3(2): 196-268 (1979 ["1978"]); Dixit, Census Indian Pterid.: 8 (1984); Lycopodaceae India: 57 (1988); Pande, Indian Fern J. 7: 19 (1990); Punetha *et al.*, in Gupta, Higher Pl. Indian Subcont. 2(5): 128 (1991).

= *Lycopodium setaceum* D.Don var. *subulifolium* (Wall. ex Hook. & Grev.) C.B.Clarke, Trans. Linn. Soc. Lond. II (Bot.) 1: 590 (1880).

= *Lycopodium subulifolium* Wall. ex Hook. & Grev., Icon. Fil. 1(3): t. 49 (1827); Pande & Kandpal, Act. Botanica Indica 14 (Suppl.): 116 (1986).

= *Phlegmariurus subulifolius* (Wall. ex Hook. & Grev.) S.R. Ghosh, in S.R. Ghosh, B. Ghosh, A. Biswas & R.K. Ghosh, Pterid. Fl. Eastern India 1: 66 (2004).

Plants suberect or pendulous. Roots slender, only in the basal region of the plants. Stem up to 15 cm long, 1-2 mm diam., dichotomously forked 5-6 times, branches of dichotomy almost parallel to each other, cylindrical, stele plectostelar. Leaves sessile, small, 8.0 x 0.8-1.0 mm, linear-lanceolate, thin, falcate, entire, acute, usually twisted at base so that one of the lateral margins lies close to the stem,

leaves become gradually smaller and more compact towards stem apex, some leaves lanceolate, slightly more obtuse at their apices, spreading and without any twisting; central vein slender, faintly raised on abaxial surface, extending almost to the leaf-apex or more so in leaves in the distal region of the branch, but not below the first dichotomy. Sporangia reniform, not completely covered by the lamina, sporangial stalk stout, 4-5 cells long, 6-7 cells thick. Spores yellow, tetrahedral.

Ecology of *Huperzia pulcherrima*: Ecology: Grows epiphytically as well as, less commonly, lithophytically, between 1400 and 2500 m altitude. Scattered, but locally common to abundant and often occurs together with the *H. hamiltonii*. Between Loharkhet and Dhakuri; Khalpatta; Madhari; Jhuni; Liti

Distribution of *Huperzia pulcherrima*: India (Sikkim; Darjeeling; Meghalaya; Arunachal Pradesh; Manipur); Nepal; Bhutan; Tibet; China.

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