

## Diversity and distribution of Lycopodiaceae P. Beauvois ex Mirbel in Darjiling Hills, West Bengal, India

Nayan Thapa<sup>1</sup> and Dorjay Lama

Department of Botany, St Joseph College, North Point, Darjeeling – 734104, West Bengal, India

<sup>1</sup>Corresponding author, E-mail: nayanthapa16@yahoo.com

[Received 30.10.2015; Revised 15.12.2015; Accepted 24.12.2015; Published 31.12.2015]

### Abstract

The paper deals with the diversity and distribution of Lycopodiaceae P. Beauvois ex Mirbel in Darjiling Hills areas of Eastern Himalaya. It revealed the occurrence of 3 genera viz *Huperzia* Bernhardtii, *Lycopodiella* Holub and *Lycopodium* Linnaeus in the study area. While, *Huperzia* is represented by the highest number of 6 spp., the two other genera *Lycopodium* and *Lycopodiella* were represented by single species. The distribution of species ranged from tropical region up to the sub-alpine indicating wide ecological amplitude of the taxon. Repeated survey and failure to collect *Huperzia phlegmaria* (Linnaeus) Rothmaler and *Lycopodium veitchii* Christ by the author in the span of four years from the study area is of great concern. *Huperzia ceylanica* (Spring) Trevisan is recorded first time from West Bengal.

**Key words:** Lycopodiaceae, *Lycopodium ceylanica*, New record, West Bengal, distribution

### INTRODUCTION

Lycopodiaceae P. Beauvois ex Mirbel is the largest family of Fern-allies with about 500 species world wide and 25 species in India (Dixit 1987). Mirbel (1802) described the group in French and named the group *Lycopodia* in Latin. They occur in both the hemispheres and have wide ecological amplitude, making their presence from tropics to arctic. Presently, 3 genera are recognized viz. *Lycopodium* Linnaeus, *Huperzia* Bernhardtii, *Lycopodiella* Holub from the 12 genera concept of Holub (1975). The Darjiling Himalayan region is well explored during the post-independence period by different Indian pteridologists and enumerated Lycopodiaceae of the area. The number of species recorded by different authors include 12 spp. (Mehra & Bir 1964), 7 spp. (Hara 1971), and 13 spp. (Sen & Sen 1978). The District of Darjiling, West Bengal lies between 26°31' and 27° 13' N latitude and between 87°59' and 88°53' E longitude (O'Malley, 1907). The Hills of Darjiling with an area of 2436.55 km<sup>2</sup> with altitudinal variation ranging from ±150 m (at Sukna) to 3660 m (at Sandakphu – Phalut), presents diverse topographical conditions and offer suitable habitat for the occurrence of wide range of plants (Das 1995, 2004; Acharya & Acharya 2001). Though the district is floristically well explored but the occurrence of micro-niche in difficult terrains with negligible accessibility has lead some plants of the region remained undiscovered.

### MATERIALS AND METHOD

Regular field trips were made during April 2010 to July 2014 to document the occurrence and distribution of different members of Lycopodiaceae in various vegetation tracts of Darjiling

Hills and processed into mounted herbarium-sheets following conventional techniques (Jain & Rao 1977). Specimens were identified by matching with the pre-identified specimens in the Herbarium of the Llyod's Botanical Garden, Darjiling as well as through consultation of published literature including (Mehra & Bir 1964; Hara 1971; Mathew 1971; Chowdhury 1973; Ghosh *et al.* 2004; Fraser-Jenkins 2008; Fraser-Jenkins *et al.* 2015). The distribution of the species was noted in the field note book along with the precise altitude and coordinates with a GPS.

Voucher specimens have been deposited in the Herbarium of the Llyod's Botanical Garden and at the Herbarium of the Botany department, St. Joseph College, Darjilling.

## RESULT AND DISCUSSION

The field study revealed the occurrence of 3 genera of Lycopodiaceae within the Darjiling Hill area with a total of 8 species. The artificial key and suitable description has been provided for their identification. The absence of two species i.e. *Lycopodium vetichii* Christ and *Huperzia phlegmaria* (Linnaeus) Rothmaler is a matter of concern, as literature review revealed its presence in the Darjiling hills (Fraser-Jenkins 2008). However, *Lycopodium vetichi* was listed as a rare plant for Darjiling hills region (Fras-jenkins 2015) but the absence of *H. phlegmeria* with the extent of survey for four years in foothills namely Samsing, Sukuna, Kalijhora, Rangeet valley yielded no result. The overexploitation of this species by local nursery for ornamental purposes from the natural habitat has lead to their dwindling population. Proper conservation strategy should be undertaken by appropriate authorities for their conservation. The occurrence of *Huperzia ceylanica* from this segment of the Himalayas is a new record for West Bengal. A small population of this species is available in restricted small patches in Tumling and Jalapahar areas. The taxonomic treatment with suitable artificial keys of the species of Lycopodiaceae occurring in the Darjiling Hills has been enumerated below.

## ENUMERATION

**Lycopodiaceae** P. Beauvois *ex* Mirbel in Lamarck & Mirbel, Hist.Nat.Veg. 4: 293. 1802.

### Key to the Genera:

1. Sporangia organized in a strobilus ..... 2
  - 1a. Sporangia occurring freely i.e. does not produce strobilus ..... *Huperzia*
  2. Sporophytic plants erect ..... *Lycopodiella*
  - 2a. Sporophytic plants scrambling ..... *Lycopodium*

**LYCOPODIUM** Linnaeus, Sp. Pl. 2: 1100. 1753.

*Lycopodium japonicum* Thunberg. Fl. Jap. 341. 1784; Dixit, Cens. Indian Pterid. 9. 1984; Thapa, Pterid. Nepal 24. 2002; Ghosh, Pterid. Fl. East. Ind. I: 86. 2004; Fraser-Jenkins, Tax. Rev. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 519. 2008.

*Lycopodium pseudoclavatum* Ching, Acta Bot. Yunnan. 4(3): 222. 1982.

Herbaceous with creeping Runner, forked, green; lateral branches erect, up to 30 cm tall, 0.5 – 1 cm in diameter, multiple times dichotomously branched; Leaves microphylius , spirally arranged, dense, angled upward, linear-lanceolate, 0.4 – 0.6 × 0.2 – 0.4 cm, herbaceous, midrib indistinct, base cuneate, sessile, margin entire, apex acuminate; strobili 3 – 4 on a



**PLATE – I. Lycopods of Darjeeling Hills:** **A.** *Huperzia serrata*; **B.** *Huperzia pulcherrima*; **C.** *Huperzia squarrosa*; **D.** *Huperzia ceylanica*; **E.** *Huperzia hamiltonii*; **F.** *Lycopodium japonicum*; **G.** *Huperzia heteriana*; **H.** *Lycopodiella cernua*

peduncle, pedicels erect with varying length,  $2 - 5 \times 0.2 - 0.4$  cm, strobili cylindrical,  $3 - 8 \times 0.4 - 0.7$  cm; sporophyll broadly ovate,  $2 - 3 \times$  ca. 3 mm, papery, apex acute, with long aristate tip; sporangia slightly exposed, spores  $30 - 35 \mu\text{m}$ , tetrahedral, creamish in colour.

**Exsiccatae:** West Bengal, Darjiling Hills, Third mile, 12.08.2011, *Nayan Thapa 026A (SJC BH)*, *026B (LBH)*,  $27^{\circ} 00' 31.7''$  N and  $88^{\circ} 17' 37.4''$  E, alt.  $2154 \pm 15$  m.

**Local Distribution:** Third mile, Sukhia, Tonglu, Lava, Chimney.

**Global Distribution:** Bhutan, Cambodia, China, India, Japan, Laos, Myanmar, Nepal, Vietnam.

**LYCOPODIELLA** Holub, Preslia 36: 22. 1964.

*Lycopodiella cernua* (Linnaeus) Pich. Sermolli, Webbia 23: 166. 1968; Thapa, Pterid. Nepal 24. 2002; Fraser-Jenkins, Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 519. 2008.

*Lycopodium cernuum* Linnaeus, Sp. Pl. 2: 1103. 1753. *Lycopodium clavatum* sensu Clarke, Trans. Linn. Soc. Ser. II. Bot. 1: 592. 1880. *Lycopodium cernuum* Linnaeus var. *sikkimense* (O.F. Mull) H.S. Kung, Acta Phytotax. Sin. 18 (2): 239. 1980.

Herbaceous with creeping, forked, creamish runner; Stem erect, 30 – 60 cm heigh, Ca. 0.5 – 1 cm in diameter, dichotomously branched. Leaves microphyllous, spirally arranged, monomorphic, sessile, lanceolate,  $0.2 - 0.4 \times 0.8 - 1$  cm, entire, acuminate, base cuneate, decurrent, midrib indistinct. Strobili solitary,  $1 - 1.4 \times 0.4 - 0.6$  cm, drooping, stalked, pedicels  $0.2 - 1 \times 0.1 - 1.2$  cm. Sporophylls different from trophophylls, subulate to lanceolate, imbricate, margin membranous and irregularly toothed, apex acute; sporangia yellow, reniform; spores  $25 - 32 \mu\text{m}$ , tetrahedral, yellowish.

**Exsiccatae:** West Bengal, Darjiling Hills, Lebong, 15.08.2011, *Nayan Thapa 048A (SJC BH)*, *048B (LBH)*,  $27^{\circ} 04' 13.5''$  N and  $88^{\circ} 16' 59.7''$  E, alt.  $1550 \pm 11.5$  m

**Local Distribution:** Rungdung, Dhotrey, lebong, Jamuna.

**Global Distribution:** Bhutan, China, India, Nepal.

**HUPERZIA** Bernhardt in Shrad. J. Bot. 1800(2): 126. 1801.

#### Key to the Species:

1. Plants usually epiphytic ..... 2
- 1a. Plants usually terrestrial ..... 3
2. Leaves linear and scaly ..... 4
- 2a. Leaves ovate-lanceolate and glossy..... *H. hamiltonii*
3. Leaf margin entire ..... 5
- 3a. Leaf margin serrate ..... *H. serrata*
4. Sporangia arise in the axil of sporophylls ..... *H. squarrosa*
- 4a. Sporangia arise throughout the length of the stem in the axil of microphylls ..... *H. pulcherrima*
5. Leaves reflexed, green,  $0.5 - 1.5 \times 0.1 - .4$  cm ..... *H. heteriana*
- 5a. Leaves ascending, greenish to brownish,  $0.4 - 1 \times 0.1 - 0.3$  cm . *H. ceylanica*

*Huperzia serrata* (Thunberg) Trevisan, Atti. Soc. Ital. Sci. Nat. 17: 248. 1875; Dixit, Cens. Indian Pterid. 7. 1984; Thapa, Pterid. Nepal 23. 2002; Ghosh, Pterid. Fl. East. Ind. I:

51. 2004; Fraser-Jenkins, Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List, 519. 2008. *Lycopodium serratum* Thunberg in Murray, Fl. Jap. 341, t.38. 1784. *Urostachys serratus* (Thunberg) Herter, Bot. Arch. **3**: 13. 1923.

Terrestrial, herbaceous, rooted at base, isodichotomous branching. Stem erect, 5 – 25 cm, 0.1 – 0.4 cm in diameter, 2 – 3 times dichotomously branched, bulbils at the tip. Leaves sparse, forming right angle to the stem, lustrous, elliptic, contracted toward base, straight, 1 – 2.5 × 0.4 – 0.6 cm, thinly leathery, both surfaces glabrous, midrib conspicuously raised, base cuneate, decurrent, petiolate, irregularly toothed, acuminate. Sporophylls homomorphic with trophophylls; sporangia visible on both sides of sporophylls, yellowish, reniform to kidney shaped; ca. 0.4 – 0.8 × 0.2 – 0.4 cm; spores 22 – 32 µm, tetrahedral, yellowish.

**Exsiccatae:** West Bengal, Darjiling Hills, Lebong, 15.08.2011, *Nayan Thapa 049A (SJCBH), 049B (LBH)*, 27° 04' 13.5" N and 88° 16' 59.7" E, alt. 1550 ± 11.5 m

**Local Distribution:** Lebong, Jalapahar, Lava, Takdah, Third mile.

**Global Distribution:** Australia, Bhutan, Cambodia, China, India, Indonesia, Japan, Korea, Laos, Malaysia, Myanmar, Nepal, Philippines, Russia, Sri Lanka, Thailand, Vietnam.

*Huperzia herteriana* (Kümmerle) T. Sen & U. Sen, Fern Gaz. 11 (6): 415, f.1a-j. 1978; Dixit, Cens. Indian Pterid. 7, 1984; Thapa, Pterid. Nepal 22. 2002; Ghosh, Pterid. Fl. East. Ind. I: 58 – 59. 2004; Fraser-Jenkins, Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 518. 2008. *Lycopodium herterianum* Kümmerle, Magyar Bot. Lap. 26: 99. 1928. *Lycopodium sikkimense* Herter, Bot. Jahrb. 43: 42. 1909. *Urostachys sikkimensis* (Herter) Herter ex Nessel, Lycopod.: 52, t.7, f.1. 1939. *Urostachys herterianus* (Kümmerle) Herter, Ind, Lycopod.: 64. 1949.

Herbaceous, terrestrial, rooting at base, isodichotomous branching; erect, ascending. Stem 4 – 12 cm, 0.2 – 0.4 cm in diameter, 2 – 4 times dichotomously branched, ultimate end with bulbils. Leaves dense, reflexed, lustrous, oblanceolate, falcate, 0.6 – 1.2 × 0.1 – 0.3 cm, leathery, midrib indistinct, base cuneate, decurrent, sessile, margin straight, upper portion with small teeth, apex acute. Sporophylls homomorphic with trophophylls; sporangia visible on both sides of sporophylls, ca. 0.3 – 0.6 × 0.1 – 0.3 cm, reniform yellowish; spores 25 – 30 µm, tetrahedral, pitted, creamish-yellow.

**Exsiccatae:** West Bengal, Darjiling Hills, Chitrey, 10.08.2011, *Nayan Thapa 055A (SJCBH), 055B (LBH)*, 26° 59' 23" N and 88° 06' 57.2" E, alt. 2232 ± 15 m

**Local Distribution:** Chitrey, Tonglu, Senchal, Rachel, Jalapahar.

**Global distribution:** India, Nepal, Bhutan, China.

*Huperzia ceylanica* (Spring) Trevisan, Atti. Soc. Ital. Sci. Nat. 17: 248. 1875; Dixit., Lycopod. India 44. 1987; Fraser-Jenkins., Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 518. 2008. *Lycopodium ceylanicum* Spring, Mem. Acad. Sci. Belg. 15(1): 37. 1843; 24(2): 16. 1850; Bak. Handb. Fern allies 11. 1887. *Huperzia ceylanica* (Spring) Rothmaler, Feddes Repert. 54(1): 59. 1944 (Superfl).

Terrestrial, herbaceous, rooting at base, growing on exposed rocky surfaces; erect, 7 – 16 cm high, 0.3 – 0.6 cm in diameter, 1 – 4 times dichotomously branched. Leaves 8 whorled, green to pale green, ascending in the upper half, reflexed at the basal part, thin, ligulate, ca. 0.8 – 1 × 0.2 – 0.4 cm, sparsely serrate towards apex, midrib distinct. Sporophylls homomorphic with trophophylls, sporangia borne on the axil of leaves at the upper half, short apical part

with only vegetative leaves; sporangium ca.  $0.4 - 0.6 \times 0.2 - 0.3$  cm, reniform, yellowish; spores  $35 - 40$   $\mu\text{m}$ , tetrahedral, pitted, pale yellow.

**Exsiccatae:** West Bengal, Darjiling Hills, Chitrey, 10.08.2011, *Nayan Thapa 160A (SJCBH), 160B(LBH)*,  $26^{\circ} 59' 23''$  N and  $88^{\circ} 06' 57.2''$  E, alt.  $2232 \pm 15$  m.

**Local Distribution:** Chitrey, Jalapahar, Tonglu.

**Global Distribution:** India, Srilanka, Java.

*Huperzia squarrosa* (Froster) Trevisan, Atti Soc. Ital. Sci. Nat. 17: 247 (1875); Dixit, Cens. Indian Pterid. 8, 1984; Dixit, Lycopod. India 65, 1987; Thapa, Pterid. Nepal 23, 2002; Fraser-Jenkins, Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 519, 2008. *Lycopodium squarrosus* Froster, Fl. Ins. Austr. Prodr.: 86, 1786. *Lycopodium verticillatum* Willdenow, Sp. Pl. 5: 48, 1810. *Lycopodium hookeri* Wallich ex Hooker & Greville, Ic. Fil. 2: t. 185, 1829. *Phlegmariurus squarrosus* (Froster) A. Löve & D. Löve, Taxon 26 (2-3): 324, 1977. *Urostachys squarrosus* (Froster) Herter, Bot. Arch. 3: 14 (1923), Ind. Lycopod. 83, 1949.

Epiphytic; stems caespitose, branches pendulous, 1 – 8 times forked, 25 – 75 cm long, 0.2 – 0.5 cm in diameter. Trophophylls lustrous, lanceolate, attached at right angles,  $0.5 - 2 \times 0.2 - 0.4$  cm, leathery, midrib distinct, margin entire, acute, base cuneate, decurrent. Strobili terminal on branches; sporophylls densely arranged, ovate-lanceolate,  $0.6 - 1.2 \times \text{ca. } 0.2$  cm, entire, acute; sporangia yellowish, reniform, vertically bisected; spores  $28 - 35$   $\mu\text{m}$ , tetrahedral, greenish-white.

**Exsiccatae:** West Bengal, Darjiling Hills, Mangwa, 10.09.2012, *Nayan Thapa 075A (SJCBH), 075B(LBH)*,  $27^{\circ} 02' 12''$  N and  $88^{\circ} 20' 1.3''$  E, alt.  $1050 \pm 15$  m

**Local Distribution:** Mangwa, Teesta valley, Makaibari, Pandam.

**Global Distribution:** India, Nepal, Bhutan, China, Cambodia, Laos, Madagascar, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand.

*Huperzia hamiltonii* (Sprengel) Trevisan, Atti Soc. Ital. Sci. Nat., 248, 1875; Dixit, Cens. Indian Pterid. 7, 1984; Dixit, Lycopod. India 48, 1987; Thapa, Pterid. Nepal 22, 2002; Fraser-Jenkins, Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 518, 2008. *Lycopodium hamiltonii* Sprengel in Linnaeus, Syst. Veg. 5: 492, 1828. *Lycopodium obtusifolium* Hameed ex D. Don, Prodr. Fl. Nepal.: 18, 1825, non Swartz (1806). *Lycopodium aloifolium* Wallich ex Hooker & Greville, Ic. Fil.: t. 233, 1831. *Lycopodium empetrifolium* Dalzell, Hook. J. Bot. 1852. *Phlegmariurus hamiltonii* (Sprengel) A. Löve & D. Löve, Taxon 26 (2 – 3): 324, 1977. *Urostachys hamiltonii* (Spring) Herter ex Nessel, Lycopod.: 68, 1939; Ind. Lycopod.: 63, 1949.

Plants epiphytic, pendulous,  $8 - 10 \times 0.2 - 0.4$  cm, forked dichotomously; Trophophylls slightly angled upward, slightly oblong,  $1 - 1.5 \times 0.3 - 0.5$  cm, base cuneate, decurrent, lustrous, leathery, midrib distinct, margin entire, apex obtuse; Sporophyll like vegetative leaves, sporangia on the axil of sporophyll in the upper half, Sporangia Ca.  $0.6 - 1 \times 0.2 - 0.4$  cm, reniform, vertically bisected yellowish; Spores  $28 - 32$   $\mu\text{m}$ , tetrahedral, pitted, pale in colour.

**Exsiccatae:** West Bengal, Darjiling Hills, Singamari, 02.07.2011, *Nayan Thapa 010A (SJCBH), 010B (LBH)*,  $27^{\circ} 03' 15.1''$  N and  $88^{\circ} 14' 23.1''$  E, alt.  $1950 \pm 12$  m

**Local Distribution:** Singamari, Senchal, Lava, Chimney.

**Global Distribution:** India, Nepal, Bhutan, China, N. Myanmar.

*Huperzia pulcherrima* (Wallich ex Hooker & Greville) Pich. Sermolli, Webbia 25(1): 219 – 297. 1970; Dixit, Cens. Indian Pterid. 8, 1984 & Lycopod. India 60. 1987; Thapa, Pterid. Nepal 23. 2002; Fraser-Jenkins, Tax. Revi. Three Hundr. Ind. Subcon. Pter. With Rev. Cen. List 519. 2008. *Lycopodium pulcherrimum* Wallich ex Hooker. & Greville, Ic. Fil.: t.38. 1827. *Lycopodium setaceum* Hameed ex D. Don, Prodr. Fl. Nepal. 18. 1825. *Lycopodium setaceum* Hameed ex D. Don var. *pulcherrimum* (Wallich ex Hooker & Greville) C.B. Clarke, Trans. Linn. Soc. Lond. II Bot.1: 590. 1880. *Lycopodium taiwanense* C.M. Kuo, Taiwania 30: 51. 1985; Tsai & Shieh, Fl. Taiwan ed.2, 1: 43. 1994. *Phlegmariurus pulcherrimus* (Wallich ex Hooker & Greville) A. Löve & D. Löve, Taxon 26 (2 – 3): 324. 1977. *Urostachys pulcherrimus* (Wallich ex Hooker & Greville) Herter, Ind. Lycopod.: 77. 1949.

Epiphytic herb; stem pendulous, 10 – 50 cm long, 0.8- 1.4 cm in diameter, 2 – 4 times forked. Leaves linear, 0.8 – 1.2 × 0.2 – 0.5 cm, erecto-patent, margins wavy, involute, slightly decurrent at base, midrib indistinct, yellowish-green. Sporophyll like vegetative leaf, fertile from the middle to the apex; sporangia in the axil of sporophylls, ca. 0.3 – 0.6 × 0.1 – 0.3 cm, kidney shaped, yellowish; spores 28 – 30 µm, tetrahedral, pitted, yellowish.

**Exsiccatae:** West Bengal, Darjiling Hills, Rungdung, 05.07.2011, *Nayan Thapa 012A (SJC BH), 012B(LBH)*, 27° 01' 16" N and 88° 16' 24.5" E, Alt. 1455 ± 13.1 m

**Local Distribution:** Rungdung, Mungpoo, Mangwa, Balason, Barnesbeg.

**Global Distribution:** Sri lanka, India, Bhutan, Nepal.

#### LITERATURE CITED

- Acharya, K. & Acharya, R. 2001. *Cyathus* and *Geastrum* – An addition to Darjeeling mycoflora. *Indian For.* 127: 959 – 952.
- Chowdhury, N.P. 1973. Notes on some Indian species of *Lycopodium* with remarks on distribution of the genus in India. *Trans. Nat. Inst. Sci. India* 1: 187 – 226.
- Das, A.P. 1995. Diversity of the Angiospermic flora of Darjeeling Hills. In A.K. Pandey (ed.), *Taxonomy and Biodiversity*. CBS, New Delhi. Pp. 118 – 127.
- Das, A.P. 2004. Floristic studies in Darjiling hills. *Bull. Bot. Surv. India* 46(1-4): 1 – 18.
- Dixit, R.D. 1987. *Lycopodiaceae of India*. Bishen Singh Mahendra Pal Singh, Dehradun
- Fraser-Jenkins, C.R. 2008. *Taxonomic revision of three hundred Indian subcontinental pteridophytes with a revised census list*. Bishen Singh Mahendra Pal Singh, Dehradun.
- Fraser-Jenkins, C.R.; Kandel, D.R. & Pariyar, S. 2015. *Ferns and fern-allies of Nepal* 1 pp. 352. National Herbarium and Plant Laboratories, Dept. of Plant Resources, Ministry of Forests and Soil Conservation, Govt. of Nepal, Kathmandu, Nepal.
- Ghosh, S.R.; Ghosh, B.; Biswas, A. & Ghosh, R.K. 2004. *The Pteridophytic flora of Eastern India*. Vol. 1. Botanical Survey of India, Kolkata.
- Hara, H. 1971. Pteridophyta. In, *The Flora of Eastern Himalayas*, 2<sup>nd</sup> report, University of Tokyo, Japan. Pp. 453 – 500.
- Holub, J. 1975. *Diphasiastrum*, a new genus in Lycopodiaceae. *Preslia* 47: 97 – 110.

- Jain, S.K. & Rao, R.R. 1977. *Field and Herbarium methods*. Today and Tomorrow's Printers and publisher, New Delhi.
- Matthew, K.M. 1971. Pteridophytes from the Darjeeling District. *Bull. Bot. Soc. Bengal* 25(1-2): 97 – 102.
- Mehra, P.N. & Bir, S.S. 1964. *Pteridophytic flora of Darjeeling and Sikkim Himalayas*. Bishen Singh Mahendra Pal Singh, Dehradun.
- Mirbel, C.F & Brisseau .D.E. 1802. Vols 3-5 In: J.A.P. Lamarck & Brisseau de C.F. Mirbel (Eds), *Histoire Naturelle des vegetaux*, 15 vols. Deterville, Paris.
- O'Malley, L.S.S. 1907 (Repr. 1999). *Bengal District Gazetteers Darjiling*. Gyan Publishing House, New Delhi.
- Sen, T. & Sen, U. 1978. Morphology, anatomy and taxonomy of Lycopodiaceae of the Darjeeling Himalayas. *Fern Gaz.*11(6): 413 – 427, figs. 1 – 5.