RESEARCH ARTICLE

Pteridophytes of Sechu Tuan Nalla Wildlife Sanctuary, Chamba district, Himachal Pradesh, India

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Abstract

A total number of 30 taxa belonging to 14 genera and nine families have been documented. Of these, seven species namely, *Selaginella jacquemontii* Spring, *Equisetum arvense* L., *Cryptogramma stelleri* (S.G. Gmel.) Prantl, *Gymnocarpium fedtschenkoanum* Pojark., *Deparia subsimilis* (Christ) Fraser-Jenk., *Dryopteris juxtaposita* Christ, *Polystichum sinense* (Christ) Christ are reported here first time from Chamba district of Himachal Pradesh and six species, viz., *Adiantum venustum* D. Don, *Asplenium trichomanes* L., *Athyrium attenuatum* (C.B. Clarke) Tagawa, *Dryopteris juxtaposita* Christ, *Equisetum arvense* L., *Pteridium revolutum* (Blume) Nakai are ethnobotanically important.

Keywords: Ferns, Himalayas, Pangi Valley, Pteridophytes.

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Introduction

The Sechu Tuan Nalla Wildlife Sanctuary, a high-altitude sanctuary, lies in Sechu Valley, a sub-valley of the Pangi Valley situated at the northwestern boundary of the Chamba district of Himachal Pradesh. The sanctuary is situated between geographic coordinates 32°49'57.9''N to 33°10'50.6''N latitude and 76°34'56.7''E to 76°46'37.5''E longitude (Fig. 1), with elevation ranging from 2500 to 6000 m. asl. It nestled deep within the Great Himalayas, a biodiversity hotspot within the country. It shares the interstate boundary of Jammu and Kashmir in the North and the Lahaul-Spiti district of Himachal Pradesh in the northeast and southeast. Because of its remote location and challenging terrain, this area has remained unexplored and was not included in previous floristic studies (Bhattacharyya & Uniyal, 1982; Singh & Sharma, 2006; Deroliya *et al*., 2019) of the Chamba district. Though, Mehra & Dhir (1968) studied the diversity of pteridophytes of Dalhousie Hill and reported 88 species of ferns and six fern allies. Khullar (1994, 1995, 2000) reported a total of 232 taxa of ferns from Himachal Pradesh (excluding 33 doubtful records) while working in Western Himalaya. As such, any information about the pteridophytic diversity of this sanctuary is lacking. Therefore, efforts have been made to gather information about the pteridophytes present in the study area.

All these taxa have been recorded for the first time from Sechu Tuan Nalla Wildlife Sanctuary, whereas *Selaginella jacquemontii* Spring, *Equisetum arvense* L., *Cryptogramma stelleri* (S.G. Gmel.) Prantl, *Gymnocarpium fedtschenkoanum* Pojark., *Deparia subsimilis* (Christ) Fraser-Jenk., *Dryopteris juxtaposita* Christ, *Polystichum sinense* (Christ) Christ are reported here first time from the Chamba district of Himachal Pradesh.

Material and Methods

Field surveys and plant collection tours were carried out throughout the Wildlife Sanctuary in different seasons between 2016 and 2019. Different habitats were explored. Data pertaining to habit, habitat, elevation, and important taxonomic characters of the species were noted and field photographs were also taken. One of the authors (PK) collected ferns and fern allies for assessment of the pteridophytic diversity of the sanctuary. The collected specimens were processed and preserved following Jain & Rao (1977). Identification of the collected specimens was carried out with the help of regional flora (Khullar, 1994, 1995, 2000; Pande & Pande 2002, 2003; Pande *et al.,* 2012). Further confirmation of the specimens was done at the herbaria of the Botanical Survey of India, Dehradun (BSD) and the Forest Research Institute, Dehradun (DD). Identified and properly labeled specimens have been deposited in the herbarium of the Botanical Survey of India, Northern Regional Centre, Dehradun (BSD).

All the families are arranged according to PPG I (2016) and the genera within each family and species within a genus are arranged alphabetically. The current scientific name of each species has been presented with authority and protologue citation. This is followed by the basionym (if any), taxonomic description, distribution of the taxon in the wildlife sanctuary, habitat, distribution altitude and exsiccate of the collected specimen.

Results and Discussion

This study revealed that the sanctuary inhabits a total of 30 taxa (including 28 species and two subspecies) under 14 genera belonging to nine families of pteridophytes (Table 1).

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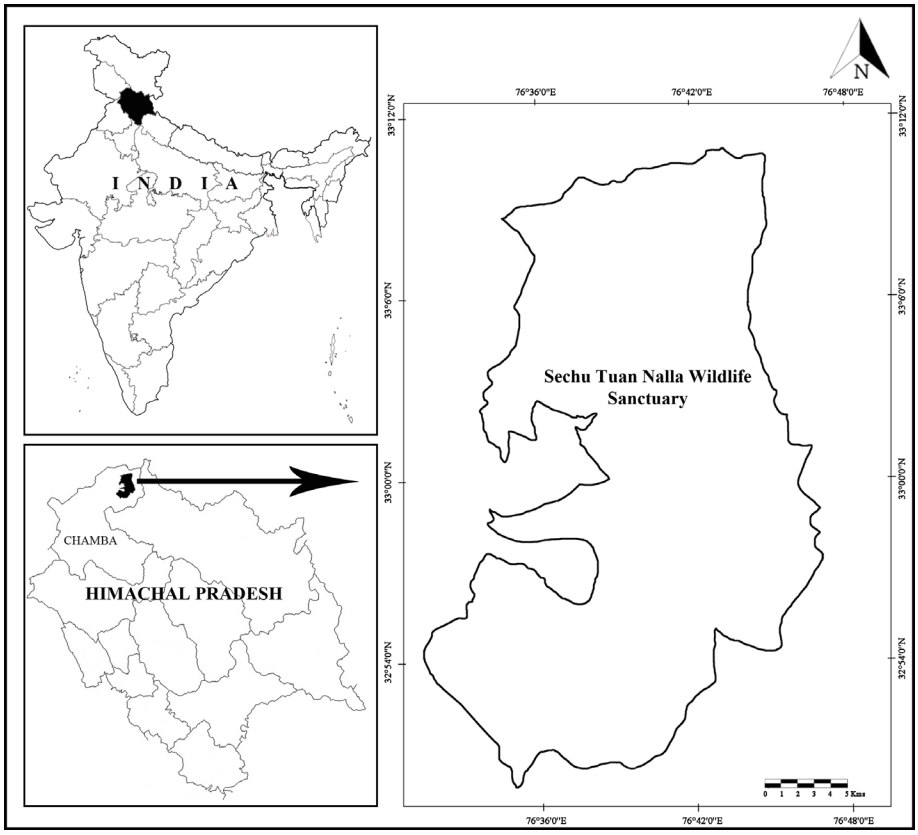

Fig. 1: Map of Sechu Tuan Nalla Wildlife Sanctuary, Chamba district, Himachal Pradesh

Systematic Enumeration

Family - Selaginellaceae

Selaginella jacquemontii Spring, Bull. Acad. Roy. Sci. Bruxelles 10(1): 226. 1843. *S. kashmiriana* R.D. Dixit, Census Indian Pteridophytes: 14. 1984.

Plant 5 to 15 cm long, slender, pinkish-red, except apical stramineous-green part, branched throughout; branches lax, pinnate, ascending. Rhizophores wiry, confined to base. Leaves heteromorphic, distant on central stem, pale to deep green, with median vein; lateral leaves obovate, base oblique, apex mucronate, inner margin ciliolate, outer margin dentate; axillary leaves similar to the lateral leaves; median leaves smaller, obovate. Strobili 6–8 × 1–2 mm, solitary terminal. Sporophylls alike sterile leaves, uniform, adpressed, ovate, and acute-dentate. Megaspores reddish-brown, granular. Microspore yellow (Fig. 2A)

Occasional, on moist rocky substratum in partly shaded places in between 2900 to 3035 m altitude.

Specimens examined: Sidhani Dhar, *P. Kumar* 127984; Harbi Dhar, *P. Kumar* 127338; Sechu Dhar, *P. Kumar* 127739.

Family - Equisetaceae

Equisetum arvense L., Sp. Pl. 2: 1050. 1753.

Plant 10–50 cm tall. Rhizome long creeping; stems dimorphic. Sterile stem 10 to 50 cm tall, 0.2 to 0.5 cm in diam., green, caudate, with 6 to 12 ribs, central hollow, ribs distinctly grooved; branches regular, densely whorled, solid; leaf sheaths loose, teeth lanceolate, black with a white membranous margin. Fertile stems, smaller than sterile, not branched, pale brown; leaf sheaths distant, 2 to 5 cm long, brown, membranous. Cones 2 to 4 cm long, fugacious, shortly stalked, obtuse. Sporophylls peltate.

Common, in moist shady places and along streams in between 2800 to 3400 m altitude.

Specimens examined: Along Triund Nalha, *P. Kumar* 127853; Sidhani Dhar, *P. Kumar* 127971; Topiyun Dhar *P. Kumar* 128079.

Family - Ophioglossaceae

Botrychium lunaria (L.) Sw., J. Bot. (Schrader) 1800(2): 110. 1801. *Osmunda lunaria* L., Sp. Pl. 2: 1064. 1753.

Plant 10 to 15 cm high, glabrous, dimorphic fertile spike and sterile lamina arises from a short common stipe. Rhizome 2 to 4 cm long, cylindrical, erect, enclosed with brownish sheath. Stipe 4 to 7 cm, green, stipe apex bifurcates into tropophyll and fertile spike. Tropophyll pinnate, 3–8 × 2–3 cm, oblong, thick; pinnae 4 to 8 pairs, reniform, frequently overlapping, margins crenate, glabrous, apical lobe deeply notched. Fertile spike 4 to 8 cm long, stalked, 5 to 8 pairs of sporangial clusters present alternately on either side. Spores yellow with smooth exine.

Occasional, in alpine grassy and shady places in mixed *Betula* and coniferous forest in between 3200 to 3700 m altitude.

Specimens examined: Towards North of Bhatori Seri along Sindhmarh Nalla, *P. Kumar* 127531; on way to Sidhani Dhar, *P. Kumar* 132550.

Family - Pteridaceae

Adiantum tibeticum Ching & Y.X. Lin, Acta Phytotax. Sin. 18: 104. 1980. *A. venustum* subsp. *tibeticum* (Ching & Y.X. Lin) Khullar, Indian Fern J. 26(1–2): 82. 2009.

Table 1: Pteridophytes of Sechu Tuan Nalla Wildlife Sanctuary

S. No.	*Name of the species*	*Family*
1	*Selaginella jacquemontii* Spring	Selaginellaceae
2	*Equisetum arvense* L.	Equisetaceae
3	*Botrychium lunaria* (L.) Sw.	Ophioglossaceae
4	*Adiantum tibeticum* Ching & Y.X. Lin	Pteridaceae
5	*Adiantum venustum* D. Don	Pteridaceae
6	*Cryptogramma brunoniana* Wall. ex Hook. & Grev.	Pteridaceae
7	*Cryptogramma stelleri* (S.G. Gmel.) Prantl	Pteridaceae
8	*Pteridium revolutum* (Blume) Nakai	Dennstaedtiaceae
9	*Asplenium adiantum-nigrum* L.	Aspleniaceae
10	*Asplenium fontanum* subsp. *pseudofontanum* (Kossinsky) Reichst. & Schneller	Aspleniaceae
11	*Asplenium septentrionale* (L.) Hoffm.	Aspleniaceae
12	*Asplenium trichomanes* L.	Aspleniaceae
13	*Asplenium viride* Huds.	Aspleniaceae
14	*Cystopteris fragilis* subsp. *dickieana* (R. Sim) Hook.f.	Aspleniaceae
15	*Cystopteris fragilis* (L.) Bernh. subsp. fragilis	Aspleniaceae
16	*Gymnocarpium fedtschenkoanum* Pojark.	Aspleniaceae
17	*Athyrium attenuatum* (C.B. Clarke) Tagawa	Athyriaceae
18	*Athyrium mackinnoniorum* (C. Hope) C. Chr.	Athyriaceae
19	*Athyrium strigillosum* (T. Moore ex E.J. Lowe) Salomon	Athyriaceae
20	*Deparia subsimilis* (Christ) Fraser-Jenk.	Athyriaceae
21	*Phegopteris connectilis* (Michx.) Watt	Thelypteridaceae
22	*Dryopteris blanfordii* (C. Hope) C. Chr.	Dryopteridaceae
23	*Dryopteris caroli-hopei* Fraser-Jenk.	Dryopteridaceae
24	*Dryopteris juxtaposita* Christ	Dryopteridaceae
25	*Dryopteris ramosa* (C. Hope) C. Chr.	Dryopteridaceae
26	*Dryopteris stewartii* Fraser-Jenk.	Dryopteridaceae
27	*Dryopteris xanthomelas* (Christ) C. Chr.	Dryopteridaceae
28	*Polystichum prescottianum* (Wall. ex Mett.) T. Moore	Dryopteridaceae
29	*Polystichum sinense* (Christ) Christ	Dryopteridaceae
30	*Polystichum thomsonii* (Hook.f.) Bedd.	Dryopteridaceae

Plants 20 to 25 cm high. Rhizome creeping, scaly; scales dense, brown, concolorous, lanceolate. Stipe erect, glossy, castaneous-brown, 8 to 12 cm long, adaxially grooved, distally glabrous; scales light-brown, concolorous, lanceolate, margin entire; rachis, costae, and stalks zigzag, same color as stipes. Lamina 3-pinnate, 10–15 × 5–8 cm, distally 1-pinnate, ovate; pinnae 4(–5) each side, 3–10 × 2–8 cm, basal pinnae 2-pinnate, narrowly ovate; pinnules 3(–4) pairs per pinna; fertile pinnules flabellate, usually 0.4–0.9 × 0.2–1.1 cm, both surfaces glabrous, base cuneate, oblique to irregularly shaped, apex rounded, with rounded sharp triangular teeth. Sori is usually 1 to 2, borne in notches at the upper margin; false indusia orbicular-reniform, brownish, membranous, persistent. Spores light-brown. (Fig. 2B)

Common, underneath rocks and in moist shady places in *Betula* and coniferous forest in between 2700 to 2907 m altitude.

Specimens examined: Sechu Dhar, *P. Kumar* 127722, 127953; Sidhani Dhar, *P. Kumar* 127977.

Adiantum venustum D. Don, Prodr. Fl. Nepal.: 17. 1825.

Plants 30 to 50 cm high. Rhizome long creeping, thin, scaly; scales dark brown, broadly lanceolate to linear-lanceolate. Stipe 10 to 20 cm long, dark brown, scaly at base, glabrous glossy above; scales light-brown, concolorous, lanceolate, margin entire; rachis glabrous, glossy. Lamina 3–4-pinnate, 20–30 × 15–20 cm, deltate, thin, herbaceous, upper surface pale-green, lower often bluish-glaucous at maturity; pinnae 5 pairs, 3–15 × 2–10 cm, deltate-ovate, alternate; ultimate pinnules 4–5 pairs, 1–5 × 0.5–15 cm, obcuneate to obovate, alternate, petiolulate, regularly toothed with small acute teeth; fertile pinnules with 2 or 3 notches. Sori 1–2(–3) borne in notches at the upper margin, indusiate; indusia pale brown, reniform, margin almost entire. Spores pale brown, smooth. (Fig. 2C)

Common, underneath rocks and in moist shady places in coniferous forests in between 2800 to 2907 m altitude.

Specimen examined: Sidhani Dhar, *P. Kumar* 127723.

Cryptogramma brunoniana Wall. ex Hook. & Grev., Icon. Filic. 2: t. 158. 1829. *C. crispa* f. *indica* Hook., Sp. Fil. 2: 128. 1858.

Plant 8 to 15 cm high, dimorphic. Rhizome stout, erect, scaly; scales yellowish brown, linear-lanceolate, membranous. Fronds tufted, dimorphic. Stipe 4 to 5 cm in sterile frond, 7 to 10 cm in fertile frond, delicate, cylindrical, stramineous, basal part scaly, glabrous above; scales as on rhizome; rachis glabrous. Sterile lamina 3(–4)-pinnate, pinnatifid, 2.5–4.0 × 1–3 cm, glabrous, shortly petiolate; pinnae 5 to 6 pairs, obovate, lobed; pinnules 3–4 pairs, pod-shaped, linear, obtuse. Fertile lamina 3-pinnate, 4–8 × 2.5–4.0 cm, oblong-ovate; pinnae 3–5 pairs; pinnules 3–4 pairs, linear pod-shaped, ultimate pinnule linear, always the largest. Sori borne near vein tips, covering the whole fertile segment, indusiate; indusia false, brown, linear. Spores light brown with reticulate exine.

Occasional, in moist shaded places and along water streams amidst boulders in between 3100–3595 m altitude.

Specimens examined: Towards North of Bhatori Seri along Sindhmarh Nalla, *P. Kumar* 127551; Along Triund Nalla towards Chogalu Dhar, *P. Kumar* 127169.

Cryptogramma stelleri (S.G. Gmel.) Prantl, Bot. Jahrb. Syst. 3: 413. 1882. *Pteris stelleri* S.G. Gmel., Novi Comment. Acad. Sci. Imp. Petrop. 12: 519. 1768.

Plant 15 to 25 cm high. Rhizome slender, creeping, scaly; scales light brown, lanceolate or ovate-lanceolate. Fronds scattered, dimorphic. Stipe distant, slender 5–8 cm long, naked, pale brown, with few scales at the base; scales ovate, pale-brown margin entire apex acute; Sterile lamina 1(–2)-pinnate, 3–5.5 × 1.5–3 cm, lanceolate-ovate, herbaceous; pinnae 3(–4) pairs, subrounded, margins entire or slightly undulate, apex obtuse. Fertile lamina 2–3-pinnate, 5–8 × 2–3 cm, ovate; pinnae 4(–5)

pairs, ovate, subsessile, basal pair largest; pinnules 1(–2) pair(s) linear, pod-shaped, ultimate pinnule linear, always the largest. Sori on the vein-ends, almost covering the entire length of pinnule, indusiate; indusia false, pale green, membranous. Spores light brown. (Fig. 2D)

Infrequent, in moist places between 3000 to 3242 m altitude.

Specimen examined: Along Triund Nalha, *P. Kumar* 127861.

Family - Dennstaedtiaceae

Pteridium revolutum (Blume) Nakai, Bot. Mag. (Tokyo) 39: 109. 1925. *Pteris revoluta* Blume, Enum. Pl.: 214. 1828. *Pteris revoluta* Blume, Enum. Pl. Javae 2: 214. 1828. *Pteridium aquilinum* var. *wightianum* (J. Agardh) R.M. Tryon, Rhodora 43: 22. 1941. *P. revolutum* var. *wightianum* (J. Agardh) Fraser-Jenk., Annot. Checkl. Ind. Pterid. 1: 178. 2016.

Plant 100 to 150 cm high. Rhizome long creeping, stout, hairy; hairs light brown, uniseriate, acicular, straight. Stipe 40 to 50 cm long, stramineous, stout, woolly at the base; hairs reddish brown to dark brown; rachis sparsely hairy to glabrous. Lamina 2 to 3-pinnate, 50–100 × 30–50 cm, deltoid, sub-coriaceous to coriaceous, white-hairy; pinnae 10 to 15 pairs, alternate to opposite, lanceolate, obtuse, base subtruncate, margins often revolute, apex acuminate, lowermost pinnae largest; pinnules 10 to 15 pairs, lanceolate, sessile, margin deeply lobed to costa, lobes triangular or oblong. Sori marginal, linear, continuous, indusiate; indusia double, inner obsolete, membranous; outer formed by reflexed lamina margin. Spores brown, smooth (Fig. 2E).

Abundant, in open places on slopes and openings in coniferous forests in between 2500–3200 m altitude.

Specimen examined: Along Triund Nalla towards Chogalu Dhar, *P. Kumar* 127149.

Family - Aspleniaceae

Asplenium adiantum-nigrum L., Sp. Pl., ed. 2: 1081. 1753.

Plant 25–45 cm long. Rhizome short creeping, decumbent or ascending, scaly; scales dark brown, linear, lanceolate, apex long acuminate. Stipe 10–16 cm long, blackish brown, glossy, base scaly; scales blackish, lanceolate, clathrate, fibrillose; rachis firm, stramineous, dark brown or green. Lamina 2-3 pinnate, usually 3-pinnatifid at base, pinnate above, 10–25 × 5–12 cm, triangular-lanceolate or ovate-lanceolate, thick, coriaccous, greyish green, glabrous; pinnae 5–10 pairs, 3–6 × 2–4 cm, deltate-ovate, alternate, petioluled pinnules 2–5 pairs, ovate or oblong, apex acute or acuminate, margins acutely dentate-serrate; Sori 0.2–0.4 cm long, linear, indusiate; indusia membranaceus, whitish, margin entire or sinuate. Spores dark-brown.

Occasional, in shady places up to 3000 m altitude.

Specimen examined: Sechu Dhar, *P. Kumar* 127726.

Asplenium fontanum subsp. ***pseudofontanum*** (Kossinsky) Reichst. & Schneller, Candollea 37(1): 124. 1982. *A. pseudofontanum* Kossinsky, Bot. Mater. Gerb. Glavn. Bot. Sada R.S.F.S.R. 3: 122. 1922.

Plant delicate, 12–25 cm long. Rhizome short, ascending, apex scaly scales brown, broad lanceolate, margin more or less entire. Stipe 4.5–8.0 cm long, thin, fragile, blackish at base scales as on rhizome but becoming hair-like upwards; rachis scantly fibrillose or glabrous. Lamina finely dissected, 2(–3)-pinnate, 8–20 × 1.5–5 cm, oblong-lanceolate, glabrous; pinnae 10–30 pairs, 2–3 × 0.8–1.2 cm, lanceolate, alternate, very shortly

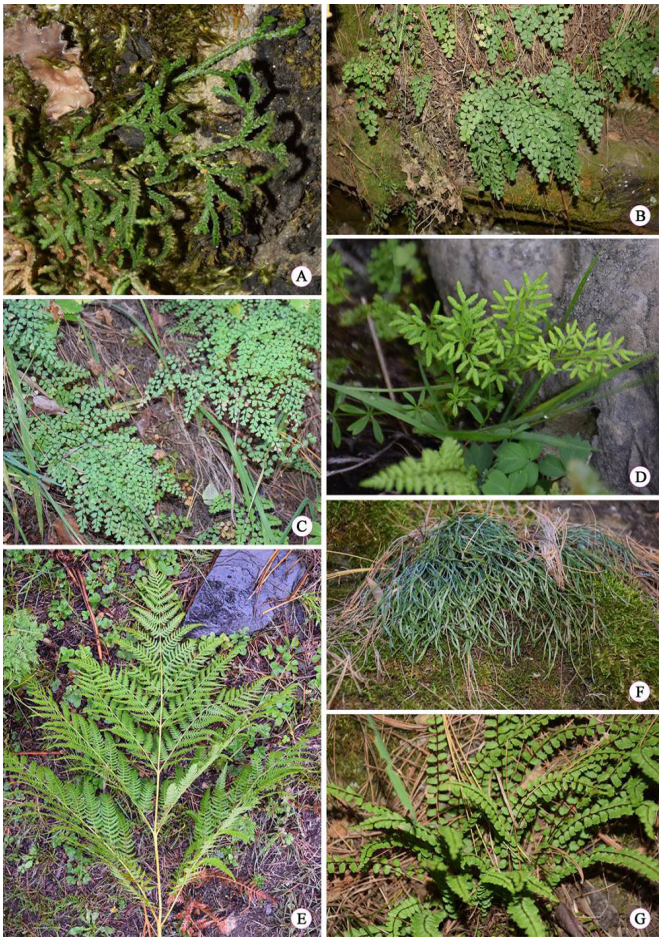

Fig. 2: (A-G) A. *Selaginella jacquemontii* Spring, B. *Adiantum tibeticum* Ching & Y.X. Lin, C. *Adiantum venustum* D. Don, D. *Cryptogramma stelleri* (S.G. Gmel.) Prantl, E. *Pteridium revolutum* (Blume) Nakai, F. *Asplenium septentrionale* (L.) Hoffm., G. *Asplenium trichomanes* L.

petiolate; basal pinnae gradually becoming distant, reduced, sessile, less dissect; basal pinnules the largest and divided into 3–5(–7) irregular triangular ovate lobes. Sori 1–2 per lobe at maturity covering the entire segments, indusiate; indusia small, elongated. Spores dark-brown.

Occasional, occur amidst rocks and rock crevices in between 2500–2900 m altitude.

Specimen examined: Sechu Dhar, *P. Kumar* 127728.

Asplenium septentrionale (L.) Hoffm., Deutschl. Fl., Theil 2 (Hoffm.) 12. 1796. *Acrostichum septentrionale* L., Sp. Pl. 2: 1068. 1753.

Plant 6–13 cm long. Rhizome short creeping, thick, covered by persistent stipe bases, scaly; scales dark-brown to blackish linear-lanceolate, margins fimbriate, apex subulate. Stipe tufted, 3–8 cm long, sparsely scaly; scales blackish, linear-lanceolate, margin entire; rachis green, glabrous. Lamina 1-pinnate or simple, 3–5 cm long, shorter than stipe, linear lanceolate, dichotomously 2(–3)-partite into long, narrow-linear, glabrous segments or pinnae, texture herbaceous or subcoriaceous; pinnae 2–3 pairs, small, alternate, petiolate, base attenuate, apex acutely 2(–3)-toothed. Sori narrow, linear, elongated, confluent

at maturity, covering the entire segments, indusiate; indusia pale brown or white, entire. Spores brown. (Fig. 2F)

Common, in rock crevices at partly shaded forest slopes and alpine hills in between 2800–3600 m altitude.

Specimens examined: Sechu Dhar, *P. Kumar* 127740; Towards North of Bhatori Seri along Sindhmarh Nalla, *P. Kumar* 127553; Along Jambu Nalla towards Ghatitar, *P. Kumar* 127253.

Asplenium trichomanes L., Sp. Pl. 2: 1068. 1753.

Plant 8–15 cm long. Rhizome short, erect, covered by persistent stipe bases, apex scaly; scales dark brown, linear-lanceolate, margins fimbriate or almost entire. Stipe 1–4(–7) cm long, tufted, blackish brown, glossy, glabrous; scales as on rhizome but becoming smaller upwards; rachis similar to stipe, fibrillose. Lamina 1-pinnate, 5–15 × 0.5–2 cm, linear-lanceolate, subcoriaceous, glabrous; pinnae 10–20 pairs, orbicular or sub-oblong, alternate, sessile to petiolate, base cuneate, margins finely crenate-serrate, apex rounded or obtuse; basal pinnae distant, reduced; apical pinnae smaller. Sori 0.2–0.3 cm long, linear, on each side of costa, obliquely pointing to pinnae apex, indusiate; indusia thin, margin entire. Spores dark brown. (Fig. 2G)

Occasional, in moist, shaded places and amidst rocks in between 2800–3600 m altitude.

Specimens examined: Along Triund Nalla enroute for Chogalu Dhar, *P. Kumar* 127186; Sechu Dhar, *P. Kumar* 127301; Towards North of Bhatori Seri along Sindhmarh Nalla, *P. Kumar* 127552.

Asplenium viride Huds., Fl. Angl. (Hudson) 385. 1762, as '*viridi*'

Plant 8–20 cm long. Rhizome short, erect, apex scaly; scales dark brown, lanceolate, margins entire. Stipe 3–5 cm long or longer, dark brown at base; rachis green, grooved adaxially, glabrous. Lamina 1-pinnate, 5–15 × 0.8–1.2 cm, linear-lanceolate, herbaceous, glabrous; pinnae 10–20 pairs, 0.4–0.7 × 0.3–0.4 cm, ovate to orbicular, alternate, short petiolate, base cuneate, margins crenate; basal pinnae distant, slightly smaller. Sori linear, near the costa, indusiate; indusia brown, crenate. Spores dark brown.

Occasional, in moist shady localities, up to 3300 m altitude.

Specimen examined: Along Triund Nalha, *P. Kumar* 127860.

Cystopteris fragilis (L.) Bernh. in Schrader, Neues J. Bot. 1(2): 27. 1806. *Polypodium fragile* L., Sp. Pl. 2: 1091. 1753.

Plant 30–50 cm high. Rhizome short creeping, thin, scaly; scales light-brown, concolorous, lanceolate, apex acuminate, margin entire. Stipe 4–15 cm long, stramineous or pale brown, fragile, scaly at base; scales light-brown, concolorous, lanceolate, margin entire, apex acuminate; rachis stramineous or pale brown, sparsely glandular-hairy. Lamina 2-pinnate, 10–20 × 4–6 cm, lanceolate, glabrous, herbaceous; pinnae 8–15 pairs, 2–5 × 1–2 cm, lanceolate or triangular-lanceolate, alternate, lowest pinnae slightly shorter than the above ones; pinnules 4–7 pairs, lanceolate or ovate-rhomboid, obtuse or acute, margins crenate, variously lobed, basal pinnules generally the largest and more lobed than the others. Sori round, medial, indusiate; indusia pale-yellow, ovate or lanceolate, hairy. Spores dark brown, exine verrucose or echinate.

subsp. ***dickieana*** (R. Sim) Hook.f., Student. Fl. Brit. Isl.: 464. 1870. *C. dickieana* R. Sim, Gard. Farmers' J. ser. 2, 2: 308. 1848. *C. sikkimensis* Ching ex Bir, Nova Hedwigia 7: 504. 1964.

Spores rugose with non-spiny or verrucose exine.

Common, in moist and shady places in between 2800–3900 m altitude.

Specimens examined: Eco-sensitive zone, towards Sidhani bia Mujh village, *P. Kumar* 128029; Sechu Dhar, *P. Kumar* 127741; Pepe Nalla, Chasakh Bhatori, *P. Kumar* 127434; Topiyun Dhar, *P. Kumar* Tuan 127685.

subsp. ***fragilis***

Spores non rugose with echinate exine.

Occasional, on moist shaded slopes in between 3000–3700 m altitude.

Specimen examined: Along Sindhmarh Nalla upwards, *P. Kumar* 127631.

Gymnocarpium fedtschenkoanum Pojark., Soobshch. Tadzh. Fil. Akad. Nauk SSSR. 22: 9. 1950.

Plant 20–40 cm long Rhizome long creeping, dark brown, thin, sparsely scaly; scales pale brown, ovate, margins entire, acuminate, sparsely and shortly glandular. Stipe 10–25 cm long, stramineous; scales sparse, light-brown, concolorous, ovate, margin entire, apex long acuminate; rachis stramineous, glabrous. Lamina 2–3-pinnate, 8–15 × 5–15 cm, deltate, light green, glabrous; pinnae 5 pairs, 7–10 × 3–4 cm, triangular-lanceolate or deltate, opposite, petiolate; pinnules 5 pairs, lanceolate, alternate, ultimate lobes 5 pairs, alternate, sessile, apex rounded, 2-toothed, margin crenate; costae and costules glabrous. Sori round, 4–6 pairs in a single row on either side of costule or 2–3 pairs on either side of the midvein of ultimate lobe, exindusiate; Spores dark brown.

Infrequent, moist places and under rocks in coniferous forests in between 2700–3750 m altitude.

Specimens examined: Sidhani Dhar, *P. Kumar* 132572; Way to Sidhani Dhar, *P. Kumar* 127771; Sechu Dhar, *P. Kumar* 127707.

Family - Athyriaceae

Athyrium attenuatum (C.B. Clarke) Tagawa, Acta Phytotax. Geobot. 16(6): 177. 1956. *A. filix-femina* var. *attenuatum* C.B. Clarke, Trans. Linn. Soc. London, Bot. 1(7): 492, t. 59(1). 1880. *A. filix-femina* var. *dentigerum* C.B. Clarke, Trans. Linn. Soc. London, Bot. 1(7): 491. 1880.

Plant 25–60 cm long. Rhizome suberect to erect, thick, stout, scaly; scales 0.5–1.2 cm long, lanceolate, yellowish brown to dark brown, concolorous. Stipe 5–16 cm long, brown or stramineous, densely scaly at base, sparsely scaly or glabrous upwards; scales brown, lanceolate, acuminate, entire margined; rachis sparsely scaly. Lamina 1-pinnate, bipinnatifid, 25–45 × 8–15 cm, broadly lanceolate, surface glabrous above; pinnae 12–20 pairs, 2.5–8 × 0.6–1.6 cm, lanceolate, alternate, petiolate, distant below, congested upwards; pinnules 18–20 pairs, oblong, alternate, serrate; costae sparsely scaly; costules glabrous, with prominent setae on upper surface. Sori brownish, linear or 'J' shaped, in single row on either side of costule, almost covering the lower surface, indusiate; indusia light brown, linear or 'J' shaped, margin fimbriate. Spores light brown, smooth.

Common, in moist places, amidst boulders in between 3100–4000 m altitude.

Specimens examined: Along Triund Nalla towards Chogalu Dhar, *P. Kumar* 127151, 127197; Pepe Nalla, Chasakh Bhatori, *P. Kumar* 127433.

Athyrium mackinnoniorum (C. Hope) C. Chr., Index Filic. 143. 1905. *Asplenium mackinnoniorum* C. Hope, J. Bot. 34: 124. 1896.

Plant 30–120 cm long. Rhizome erect or suberect, thick, scaly; scales 0.5–1.4 cm long, concolorous, brown, base cordate, margin entire, apex elongated acuminate, hair tipped. Stipe 25–40 cm long, stramineous or pinkish, thick, base densely scaly; scales concolorous brown, linear; rachis stramineous, glabrous. Lamina 2-pinnate, tripinnatifid, 30–60 × 20–45 cm, deltoid to triangular lanceolate, spreading, herbaceous, glabrous pinnae 10–20 pairs, 8–20 × 1.5–4 cm, ovate to lanceolate, distant, alternate, apex long acuminate, shortly petiolate; setae borne on upper surface of costae-apices pinnules 16–20(–25) pairs, asymmetrical, alternate, sessile, lanceolate, base decurrent, slightly auricled on the acroscopic side, apex acute, the basal 2–3 pairs of pinnules smaller than the rest in the pinna, setae confined to pinna apices; Sori brownish, linear, oblong or 'J' shaped, 3–8 pairs, in two rows, indusiate; indusia light brown, linear or 'J' shaped, persistent. Spores light-brown.

Occasional, in shady moist localities in coniferous forests in between 2700–3100 m altitude.

Specimens examined: On way to Sidhani Dhar, *P. Kumar* 127769; Sechu Dhar, *P. Kumar* 127271.

Athyrium strigillosum (T. Moore ex E.J. Lowe) Salomon, Nomencl. Gefässkrypt.: 112. 1883. *Asplenium strigillosum* T. Moore ex E.J. Lowe, Ferns 5: 107, t. 36. 1858.

Plant 35–60 cm long. Rhizome suberect to erect, thick, scaly; scales 0.3–0.7 cm long, yellowish brown, linear-lanceolate, base cordate, margin entire, apex acuminate, elongated. Stipe 10–20 cm long, stramineous or pink or purplish, thick, sparsely scaly; scales brown, concolorous linear-lanceolate; rachis stramineous or pinkish, glabrous. Lamina 2-pinnate, tripinnatifid, 20–30 × 10–15 cm, deltoid or lanceolate to narrowly triangular; pinnae 15–25 pairs, 4–10 × 2.5–4 cm, triangular lanceolate, subopposite, petiolate, basal pair slightly small to its immediate next, apex attenuate, margin deeply lobed; pinnules 8–12 pairs, *c.* 1 cm long, lanceolate, obliquely inserted, alternate, sessile to subsessile. Sori brownish, linear to 'J' shaped, oblong, 3–5 pairs, in two rows, each on either side of the costae, indusiate; indusium brown, linear, margin slightly erosed. Spores light-brown.

Occasional, occur at shady moist places, near streamlets in between 2000–3000 m altitude.

Specimen examined: Sechu Dhar, *P. Kumar* 127299.

Deparia subsimilis (Christ) Fraser-Jenk., Taxon. Revis. Indian Subcontinental Pteridophytes 239. 2008. *Athyrium subsimile* Christ, Bull. Soc. Bot. Ital. 1898: 29. 1898. *Deparia acuta* (Ching) Fraser-Jenk., New Sp. Syndr. Indian Pteridol.: 104. 1997.

Plant 50–95 cm long. Rhizome short, suberect to erect, scaly; scales dark brown or black. Stipe 20–35 cm long, stramineous, scaly at base and articulated dense hairs at upper part; scales black, concolorous ovate-lanceolate, margin entire, apex acuminate; rachis sparsely scaly. Lamina 1-pinnate, bipinnatifid, 30–60 × 10–20 cm, hairy, lanceolate, gradually narrowed toward the base; pinnae 20–25 pairs, 5–10 × 1.5–2.5 cm, lanceolate, alternate, sessile, margin deeply lobed; pinnules 10–20 pairs, 1–1.5 × 0.3–0.5 cm, lanceolate, truncate at base, margin crenate, acuminate. Sori small, 2–5 pairs per lobe, on either side of the costae, indusiate; indusium dark brown, linear, margin fimbriate. Spores brown.

Occasional, on open alpine moist slopes and damp places in between 2500–3800 m altitude.

Specimen examined: Topiyun Dhar, *P. Kumar* 127649.

Family - Thelypteridaceae

Phegopteris connectilis (Michx.) Watt, Canad. Naturalist Geol. n.s., 3(2): 159. 1867. *Polypodium connectile* Michx., Fl. Bor.-Amer. 2: 271. 1803. *Thelypteris phegopteris* (L.) Sloss. ex Rydb., Fl. Rocky Mts. 1043. 1917. *Polypodium phegopteris* L., Sp. Pl. 2: 1089. 1753.

Plant 25–35(–45) cm long. Rhizome long creeping, thin, branched, scaly; scales concolorous, brown, linear-lanceolate, apex acuminate. Stipe 15–20(–25) cm long, stramineous, base scaly; scales smaller than rhizome scales rachis winged, prominent flaps present on both sides, scaly, hairy. Lamina 1-pinnate, bipinnatifid, 8–15(–20) × (6–)8–16 cm, deltoid, base truncate, herbaceous; pinnae 5–8 pairs, 4–7 × 0.6–1.5 cm, linear-lanceolate, sessile, lowermost pair of pinnae longest, margin deeply cut into lobes; pinnules 10–15 pairs, oblique, tip subobtuse, margin entire; costa and costule hairy and scaly. Sori circular, exindusiate. Spores brown, perinate.

Occasional, in moist shady places in between 3000–3750 m altitude.

Specimens examined: Along Jambu Nalla towards Ghatitar, *P. Kumar* 127272; Way to Sidhani Dhar, *P. Kumar* 127766.

Family - Dryopteridaceae

Dryopteris blanfordii (C. Hope) C. Chr., Index Filic.: 254. 1905. *Nephrodium blanfordii* C. Hope, J. Bombay Nat. Hist. Soc. 12: 624. 1899.

Plant 30–60 cm long. Rhizome suberect, thick, densely scaly; scales reddish brown, linear-lanceolate, apex acuminate. Stipe 6–12 cm long, stramineous with dark brown base, densely scaly, fibrillose; scales concolorous, blackish-brown, broadly ovate or lanceolate, apex acuminate; rachis pale, densely scaly and fibrillose. Lamina 2-pinnate, tripinnatifid, 20–50 × 10–20 cm, oblong-lanceolate to ovate-lanceolate, herbaceous; pinnae 20–25 pairs, 8–12 × 2–3 cm, linear-lanceolate, alternate, basal pair slightly small to its immediate next; pinnules 12–20 pairs, oblong, sessile, margins shallowly lobed; costae and costules sparsely scaly. Sori small, round, indusiate, usually only the upper half of lamina fertile; indusia brown, reniform. Spores dark brown.

Common, in moist shady places, among boulders along water stream in between 2500–3800 m altitude.

Specimens examined: Eco-sensitive zone, towards Sidhani bia Mujh village, *P. Kumar* 128020; Way to Sidhani Dhar, *P. Kumar* 127773; Sidhani Dhar, *P. Kumar* 132590. Along Triund Nalla towards Chogalu Dhar, *P. Kumar* 127150.

Dryopteris caroli-hopei Fraser-Jenk., Bull. Brit. Mus. (Nat. Hist.), Bot. 18(5): 422. 1989. *Aspidium dilatatum* var. *patuloides* Christ, Mém. Soc. Bot. France 1: 41. 1905.

Plant 60–100 cm long. Rhizome long creeping, thick, scaly; scales linear-lanceolate, concolorous, stramineous, hair tipped, margin smooth. Stipe 25–45 cm long, stramineous with a brownish base, thick, densely scaly; scales yellowish-brown, concolorous, linear-lanceolate; rachis stramineous. Lamina 2–3-pinnate, 35–55 × 30–40 cm, broadly triangular-lanceolate, dark green, upper surface glabrous; pinnae 15–20 pairs, 15–25 × 4–10 cm, deltate-lanceolate, alternate, petiolate; pinnules 15–20 pairs, 5–10 × 2.5–3 cm, oblong, alternate, apex acute, obtuse, margin serrated or lobed. Sori round, paired, in two rows, each on either side between costule and costule, indusiate; indusia brown, reniform. Spores dark brown, globose.

Common, as forest undergrowth and along water course in between 2700–3700 m altitude.

Specimens examined: Sechu Dhar, *P. Kumar* 127712, 127733; Along Sindhmarh Nalla upwards, *P. Kumar* 127632; Sidhani Dhar, *P. Kumar* 132605.

Dryopteris juxtaposita Christ, Bull. Acad. Int. Géogr. Bot. sér. 3, 17(212): 138. 1907.

Plant 40–65 cm long. Rhizome long, erect, thick, scaly; scales linear-lanceolate, apex acute, margin crenate. Stipe 15–20 cm long, blackish at base, stramineous above, densely scaly at base, fibrillose below; scales black, concolorous, lanceolate to ovate-lanceolate, acuminate; rachis scaly; scales same as on stipe. Lamina 2-pinnate, 20–40 × 15–20 cm, sub-coriaceous, upper surface glabrous, green, lower surface glaucous green; pinnae 10–20 pairs, 8–12 × 3–5 cm, triangular-lanceolate, acuminate, distant, alternate, petiolate shorten towards apex; pinnules 12–20 pairs, 2.6–3.4 × *c.* 1 cm, opposite to alternate, sessile, apex rounded to truncate; costules sparsely scaly. Sori small, round, medial, indusiate; indusia pale brown, reniform, entire. Spores light brown, spherical.

Common, along forest path, in moist, shady as well as exposed places in between 2500–3000 m altitude.

Specimen examined: Sechu Dhar, *P. Kumar* 127732.

Dryopteris ramosa (C. Hope) C. Chr., Index Filic. 287. 1905. *Nephrodium ramosum* C. Hope, J. Bot. 34: 126. 1896.

Plant 50–80 cm long. Rhizome long, erect, thick, densely scaly; scales yellowish-brown, lanceolate to ovate-lanceolate, margin fimbriate, apex acuminate, elongated, dense at the base, sparse upwards. Stipe 20–30 cm long, stramineous to pale brown, scaly; scales light brown, ovate-lanceolate, margins fimbriate; rachis sparsely scaly and fibrillose or glabrous. Lamina 2-pinnate, tripinnatifid, 30–50 × 25–35 cm, deltate or widely triangular-lanceolate, green, surface glabrous above; pinnae 15–25 pairs, 15–20 × 5–8 cm, narrowly triangular-lanceolate, alternate, distant; pinnules 12–20 pairs, 2–4.5 × 1–1.6 cm, lanceolate to oblong-lanceolate, subsessile, opposite at base, alternate above, pinnatisect; costa and costules sparsely scaly. Sori small, round, 3–6 pairs, in a single row on either side of the costule, indusiate, basal 2–3 pairs of pinnae usually sterile; indusia pale brown, reniform. Spores brown.

Occasional at moist places among rocks in between 2700–3200 m altitude.

Specimen examined: Along Triund Nalha, *P. Kumar* 127884.

Dryopteris stewartii Fraser-Jenk., Kalikasan 7(3): 272. 1979.

Plant 55–70 cm long. Rhizome erect, thick, densely scaly; scales brown, lanceolate, base broad, tip acuminate, margin erosed. Stipe 15–20 cm long, stramineous, scaly and fibrillose, base densely scaly, sparsely scaly above; scales same as on stipe; rachis sparsely scaly and fibrillose. Lamina 2-pinnate, tripinnatifid, 35–45 × 15–20 cm, triangular-lanceolate, surface glabrous above; pinnae 15–22 pairs, 12–20 × 3–5 cm, lanceolate, alternate; pinnules 10–15 pairs, 1–1.8 × 0.6–1 cm, oblong-lanceolate, alternate, margins deeply lobed or serrate; costules sparsely scaly. Sori round, in two rows each on either side of the costules, indusiate; indusia brown, reniform. Spores brown.

Occasional as undergrowth at moist shady places in *Betula* forest and on alpine hill slopes in between 3000–3600 m altitude.

Specimens examined: Towards North of Bhatori Seri along Sindhmarh Nalla, *P. Kumar* 127559; Along Sindhmarh Nalla upwards, *P. Kumar* 127590; Sechu Dhar, *P. Kumar* 127273.

Dryopteris xanthomelas (Christ) C. Chr., Index Fil. Suppl: 41. 1913. *Aspidium xanthomelas* Christ, Bull. Acad. Int. Géogr. Bot., sér. 3, 16: 117. 1906.

Plant 30–50 cm long. Rhizome short, erect, thick, densely scaly; scales dark brown ovate lanceolate. Stipe 6–12 cm long, short, brown, densely scaly and fibrillose; scales 0.8–1.5 cm long, blackish brown, concolorous, thick, fibrils dark brown rachis scaly. Lamina 1-pinnate, bipinnatifid, 20–38 × 5–8 cm, broad-lanceolate, dark-green, subcoriaceous, basal pairs reduced, dorsal surface glossy; pinnae 15–22 pairs, 3–6 × 1.0–1.5 cm, alternate, sessile, lobed, basal pinnae reduced; pinnules 12–15 pairs, 0.5–1.0 × 0.3–0.4 cm, rectangular, oblong, apex truncate; costae scaly; scales light-brown, concolorous, ovate. Sori small, rounded, 3–5 pairs in two rows each on either side of the costules, indusiate; indusium brown, reniform. Spores dark-brown.

Common, in moist open places in between 2700–3600 m altitude.

Specimen examined: Towards North of Bhatori Seri along Sindhmarh Nalla, *P. Kumar* 127560.

Polystichum prescottianum (Wall. ex Mett.) T. Moore, Index Fil. 5: 101. 1858. *Aspidium prescottianum* Wall. ex Mett., Abh. Senckenberg. Naturf. Ges. 2: 332. 1858.

Plant 20–30 cm long. Rhizome erect, thick, scaly; scales concolorous, dark brown, narrowly to broadly lanceolate, acuminate. Stipe 3–5 cm long, densely tufted, stramineous to pale brown, densely scaly, fibrillose; scales light brown, concolorous, narrowly to broadly lanceolate, acuminate, margined entire, rarely with short filamentous projections; rachis densely scaly, fibrillose. Lamina 1-pinnate, bipinnatifid, 15–25 × 3–4 cm, narrowly lanceolate, herbaceous or sub-coriaceous, surfaces densely fibrillose; pinnae 18–30 pairs, 1.5–4.0 × 0.4–0.8(–1) cm, ovate-oblong to elongated-lanceolate, alternate, sessile, distant, basal pinnae reduced, margins deeply lobed to the costa; pinnules 4–8 pairs, 0.5–1 × *c.* 0.5 cm, margins serrate or spinulose; costae scaly. Sori small, 4-8 on each pinnae, in two rows, each on either side of costa, lying over costule, indusiate, only upper half of the frond fertile; indusia pale yellow to brownish, orbicular. Spores yellowish.

Occasional, in moist places along streams in between 3100–3700 m altitude.

Specimens examined: Along Triund Nalla towards Chogalu Dhar, *P. Kumar* 127198; Along Sindhmarh Nalla upwards, *P. Kumar* 127630.

Polystichum sinense (Christ) Christ, Bull. Soc. Bot. France 52, Mem. 1: 30. 1905. *P. prescottianum* var. *sinense* Christ, Bull. Soc. Bot. Ital. 1901: 289. 1901. *P. wilsonii* Christ, Bot. Gaz. 51: 353. 1911.

Plant 30–60 cm long. Rhizome short, erect, thick, densely scaly; scales dark brown, concolorous, linear-lanceolate. Stipe 10–20 cm long, tufted, stramineous, scaly, densely fibrillose; scales pale brown, concolorous, linear-lanceolate, margin erosed, tip acuminate; rachis scaly, fibrillose. Lamina 2-pinnate, 20–30 × 6–8 cm, linear-lanceolate, herbaceous, base truncate, surfaces fibrillose; pinnae 25–35(–40) pairs, 4.5–5 × 1–1.5 cm, lanceolate, alternate, sessile, base unequal, apex acuminate, with acute hair-

pointed tooth at apex, basal pinnae reduced, distant; pinnules 12–15 pairs, 0.5–0.8 cm long, oblong to narrow lanceolate, oblique, sessile, sub-opposite or alternate, apex acute, margins serrate; costae and costules scaly, fibrillose. Sori small, circular, in two rows, each on either side of costa, indusiate; indusia pale brown, orbicular, margin irregular. Spores dark brown.

Common, on open alpine moist slopes, damp places in between 3000–3650 m altitude.

Specimen examined: Topiyun Dhar, *P. Kumar* 127648.

Polystichum thomsonii (Hook.f.) Bedd., Ferns Brit. India 1: 126, t. 126. 1866. *Aspidium thomsonii* Hook.f. in Hooker, Second Cent. Ferns: t. 25. 1860.

Plant 15–25 cm long. Rhizome short, erect, scaly; scales 0.3–0.4 cm long, brown, ovate-lanceolate, margin with spiny projections, tip acuminate. Stipe 5–8 cm long, stramineous, tufted, fragile, sparsely scaly, fibrillose; scales pale brown concolorous, lanceolate, margin erosed, acute to acuminate; rachis fibrillose. Lamina 1-pinnate, bipinnatifid, 10–17 × 1.5–2 cm, linear-lanceolate, coriaceous, surfaces fibrillose; pinnae 15–25 pairs, 1–2 × 0.3–0.5 cm, alternate, basal pinnae reduced, margins lobed almost to the costa; basal lobes broadest and much oblique; pinnules 4–6 pairs, 0.2–0.3 cm long, linear; costae and costules fibrillose. Sori sub-medial, 6–8 pairs, indusiate, in a row on both side of the costa, complete frond fertile; indusia pale-brown, orbicular, margin irregular. Spores dark brown.

Occasional, in crevices of shaded damp rocks and wet places in between 3000–3500 m altitude.

Specimen examined: Harbi Dhar, *P. Kumar* 127319.

Conclusion

This study reveals that Sechu Tuan Nalla Wildlife Sanctuary harbors a considerable number of taxa of the pteridophytes. Of these, two genera *ie., Equisetum* and *Selaginella* belong to the family Equisetaceae and Selaginellaceae respectively of Fern allies. Whereas twelve genera including *Adiantum, Asplenium, Athyrium, Botrychium, Cryptogramma, Cystopteris, Deparia, Dryopteris*, *Gymnocarpium, Polystichum, Pteridium* and *Thelypteris* belong to the families Aspleniaceae, Athyriaceae, Dennstaedtiaceae, Dryopteridaceae, Ophioglossaceae, Pteridaceae and Thelypteridaceae of ferns. This study presents the first report of 30 taxa of pteridophytes collected from Sechu Tuan Nalla Wildlife Sanctuary. Among these, six species, viz., *Adiantum venustum* D. Don, *Asplenium trichomanes* L., *Athyrium attenuatum* (C.B. Clarke) Tagawa, *Dryopteris juxtaposita* Christ, *Equisetum arvense* L., *Pteridium revolutum* (Blume) Nakai, exhibit notable ethnobotanical significance (Chander *et al*., 2017; Singh *et al*., 2017; Thakur & Kanwal, 2023). The findings contribute to the existing knowledge of regional biodiversity and highlight the potential traditional applications of these species.

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Authors' contribution

All the authors have equally contributed in the preparation and finalization of the manuscript.

Conflict of interest

None

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