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Research Article

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Ptridophytes of Guma and Talo Gewog, Punakha (Bhutan)

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Abstract

This paper is an enumeration of the Pteridophytes diversity of Guma and Talo Gewog, under the Punakha district of western Bhutan. This is the first detailed study of pteridophytes in Punakha District of Bhutan which enumerated 25 pteridophytes species belonging to 17 genera and 11 families of which Pteridiaceae is the largest and dominant family having 4 genera and 9 species. Genus *Adiantum* is the largest genus with 3 species. *Diplazium esculentum*, *Dryopteris cochleata* and *Drynaria propinqua* were most common among all pteridophytes where *D. esculentum* was observed to be at high risk in the study area due to overexploitation due to their edible value. The present checklist is intended to be preliminary records of pteridophytes towards the preparation of detailed pteridophytes flora of Punakha District of Bhutan.

Keywords: Pteridophytes, Pteridiaceae, Taxonomy, Punakha District, Bhutan

1. Introduction

Pteridophytes are thriving in most and shady regions except some species which growing in extreme conditions and the first terrestrial plants having vascular tissue and reproduce using spores. They are an important part of the ground vegetation in forest communities and are proved to be good bio-indicator for climate change[1]. There are around 13,271 live species listed in a global checklist of Ferns and Lycophytes[2]. These plants are also used as foodstuffs, domestic animal bedding and are utilized in the Florist and Horticultural trades. In Eastern Himalaya, Situated on the southern slope of the Eastern Himalayas, Bhutan is a small landlocked nation covering 38,394 square kilometers. spanning the Palearctic and Indo-Malayan biogeographic zones. Bhutan's modest size belies its tremendous biodiversity, which is a result of its very varied climate and the microclimates that are created by its hilly terrain. The pteridophytic flora of Bhutan is widely recognized; Fraser-Jenkins et al.[3] provided the first thorough account of the group, listing 411 species from 27 families and 88 taxa in their checklist of pteridophytes in Bhutan. A total of 537 species (553 taxa) of ferns in 110 genera and 31 families were listed by Dorji and Thomas[4]. Fraser-Jenkins et al.[3] have assembled Bhutan's pteridophytes, or ferns and associates, with a total of 662 species.

The present paper is the preliminary report on pteridophytes of Guma and Talo gewogs under Punakha district. Guma and Talo are the two separate local governments; Gewogs (village block) (figure 1), under Punakha district of Bhutan, located in the western part of Bhutan. Guma Gewog stretches over an area of 37sq.km with an altitude ranging from 1200-2200 meter above sea level. It is located at N27038'11.7" latitude and E9046'02.0" longitude. Talo Gewog covers an area of 25.51 sq. Km with an altitude ranging from 1500-2500 msl. It is located at N27033'26.8" latitude and E89050'20.0" longitude.

2. Materials and Methods

Reconnaissance survey of the area was conducted in Punakha, to get fair knowledge of the area in early months of the study in 2022. For systematic studies, collection and transect walk was drawn on the map of study area covering all habitats and forest types using Arc GIS and Google Earth. Pteridophytes were sampled by collecting the whole plant with all details including locality, GPS coordinates, habitat, habit, collector and scientific name. Photo-plates for each species were prepared. Identification of taxa was done with the help of authentic literatures, floras, taxonomic revisions, and other related floristic works done in Bhutan and neighbouring countries[5,6].

3. Result and Discussion

In the present study 25 species of pteridophytes belonging to 18 genera and 11 families have been reported from the study area. The family Pteridiaceae was the largest and dominant family having 4 genera and 9 species, followed by Polypodiaceae (3 genera and 3 species), Woodsiaceae (2 genera and 3 species), Thelypteridiaceae (3 species) and 1 species each in Selaginellaceae, Equisetaceae, Lygodiaceae, Dryopteridaceae, Nephrolepidaceae, Davalliaceae and Dennstaedtiaceae. Genus *Adiantum* is the largest genus with 3 species followed by *Diplazium* and *Hemionitis* with 2 species each. Genus *Selaginella*, *Equisetum*, *Lygodium*, *Pteris*, *Dryopteris*, *Nephrolepis*, *Davallia*, *Onychium*, *Microlepia*, *Selliguea*, *Drynaria* and *Goniophlebium* with 1 species each (Table 1.) *Diplazium esculentum*, *Dryopteris cochleata* and *Drynaria propinqua* are frequently encountered pteridophytes in the study area. One species namely *Adiantum incisum* subsp. *incisum* has been found from Guma Gewog as new record.

Enumeration of Taxa

1. ***Selaginella monospora*** Spring, Mem. Acad. Roy. Sci. Belgique. 24: 135. (1849) (Fig. 2A) (Selaginellaceae)

Characteristics of species: Plants herbaceous, lithophytic and creeping. Strongly dimorphic sporophylls; pinkish-green, ascending, ventral and dorsal leaves ciliolate to denticulate; dorsal leaves ovate, base subcordate or obtuse, apex cuspidate-aristate.

Uses: The species grows as a low-lying, spreading mat, helping to stabilize soil and prevent erosion on slopes and in rocky areas. It also provides shelter and food for small animals, insects, and microorganisms. Small herbivore like rabbits feed on its leaves and stems.

Distribution: Species is native to Nepal to S. China and Indo-China including Bhutan.

Collection locality: Logodama under Guma gewog.

2. *Equisetum giganteum* L., Syst. Nat., ed. 10. 2: 1318 (1759). (Syn. Equisetum ramosissimum Desf.) (Fig. 2B) (Equisetaceae)

Characteristics of species: A black subterranean stem usually vertical, branched horizontally, roots borne in whole at the noods. Stem erect, larger stem with a very wide central space within, usually with fewer branches in less complete whorls; sheath tubes narrow. The plants also filter water by trapping sediments and nutrients. The thick

rhizomes hold soil particles together, to prevent erosion and sedimentation.

Uses: The species is one of the best suitable for salinity-affected areas and also used for conservation of riverine ecosystem, riverbanks, lakeshores, and marshes. Due to silica content in stem, it is used to clean and polish metalwork[7, 8].

Distribution: Species is native to Tropical & Subtropical Asia (including Bhutan) to SW. Pacific.

Collection locality: Bebigarkha under Guma gewog.

Table 1: Diversity of Pteridophytes of Guma and Talo Gewogs under Punakha district

Sl. No.	Name of the Families	Name of the Genus	Name of Species
1	Selaginellaceae	*Selaginella*	1. *Selaginella monospora* Spring
2	Equisetaceae	*Equisetum*	2. *Equisetum giganteum* L.
3	Lygodiaceae	*Lygodium*	3. *Lygodium japonicum* (Thunberg in Murray) Swartz
4	Woodsiaceae	*Athyrium*	4. *Athyrium drepanopterum* (Kunze) A. Braun ex Milde
		Diplazium	5. *Diplazium esculentum* (Retzius) Swartz
			6. *Diplazium maximum* (D. Don) C. Christensen
5	Dryopteridaceae	*Dryopteris*	7. *Dryopteris cochleata* (Buchanan-Hamilton ex D. Don) C. Christensen
6	Nephrolepidaceae	*Nephrolepis*	8. *Nephrolepis cordifolia* (L.) C. Presl
7	Davalliaceae	*Davallia*	9. *Davallia trichomanoides* Blume
8	Pteridiaceae	*Hemionitis*	10. *Hemionitis albomarginata* (C.B.Clarke) Christenh.
			11. *Hemionitis bicolor* (Roxb.) Christenh.
		Adiantum	12. *Adiantum incisum* Forssk.
			13. *Adiantum philippense* subsp. *philiphense* Fraser-Jenkins
			14. *Adiantum incisum* subsp. *incisum* Forssk.
		Pteris	15. *Pteris grandifolia* L.
			16. *Pteris biaurita* subsp. *walkeriana* Fraser-Jenk. & Dominic Raj kumar
			17. *Pteris wallichiana* Agardh
		Onychium	18. *Onychium vermae* Fraser-Jenkins & Khullar
9	Thelypteridiaceae	*Phegopteris*	19. *Phegopteris aurita* (Hook.) J.Sm.
		Thelypteris	20. *Thelypteris cana* (Baker) Ching
			21. *Thelypteris arida* (Don) Morton
10	Dennstaedtiaceae	*Microlepia*	22. *Microlepia platyphylla* (D. Don) J. Smith
1	Polypodiaceae	*Selliguea*	23. *Selliguea capitellata* (Mett.) X.C.Zhang & L.J.He
		Drynaria	24. *Drynaria propinqua* (Wallich ex Mettinues) Smith
		Goniophlebium	25. *Goniophlebium lachnopus (*Wall. ex Hook.) Bedd.

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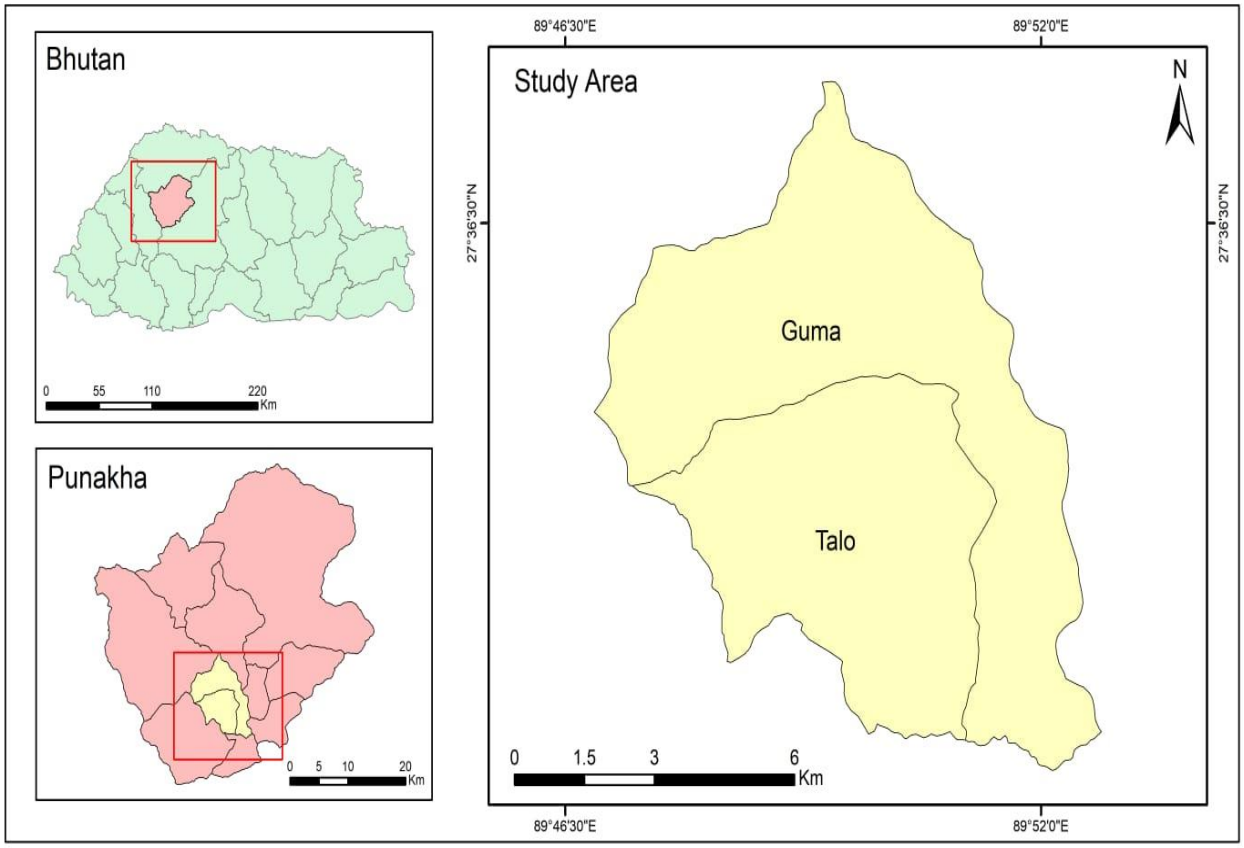

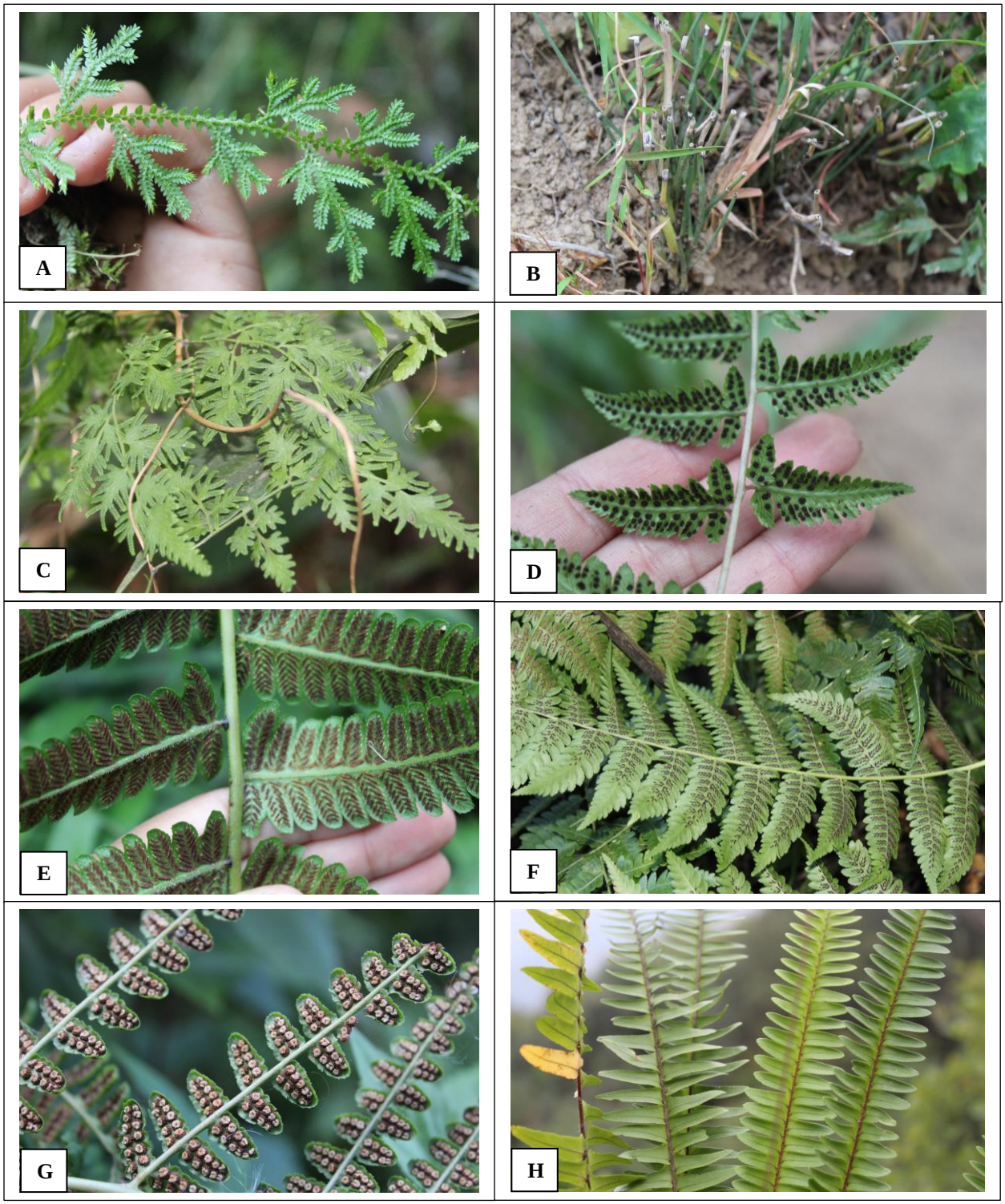

Figure 2. A. *Selaginella monospora;* B. *Equisetum giganteum* L*;* C. *Lygodium japonicum;* D. *Athyrium drepanopterum;* E. *Diplazium esculentum;* F. *Diplazium maximum;* G. *Dryopteris cochleata;* H. *Nephrolepis cordifolia*.

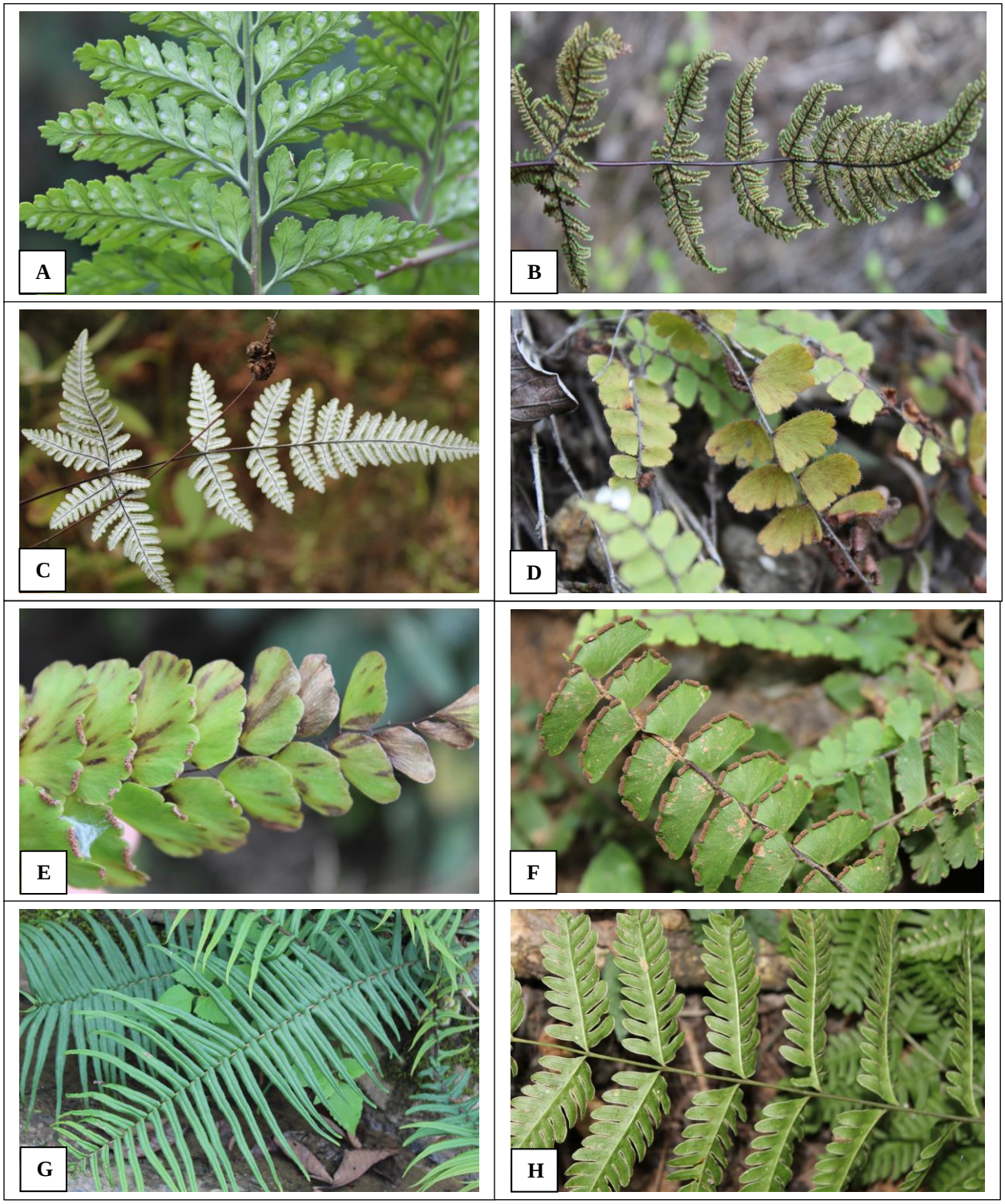

Figure 3. A. *Davallia trichomanoides;* B. *Hemionitis albomarginata;* C. *Hemionitis bicolor;* D. *Adiantum incisum;* E. *Adiantum philippense* subsp. *philiphense;* F. *Adiantum incisum* subsp. *incisum;* G. *Pteris grandifolia;* H. *Phegopteris aurita*.

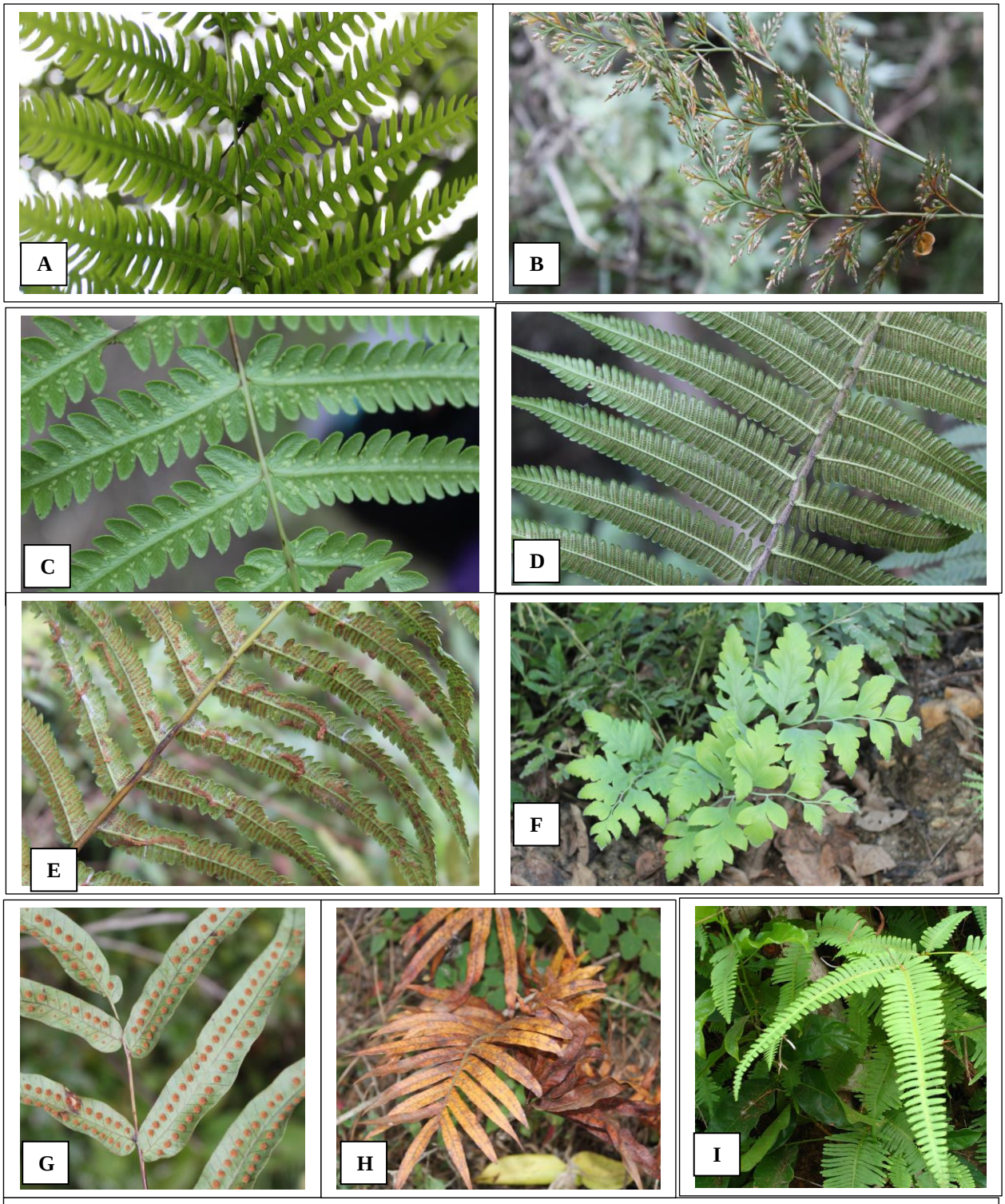

Figure 4. A. *Pteris wallichiana;* B. *Onychium vermae;* C. *Thelypteris aurita;* D. *Thelypteris cana;* E. *Thelypteris arida;* F. *Microlepia platyphylla;* G. *Selliguea capitellata;* H. *Drynaria propinqua;* I. *Goniophlebium lachnopus*

3. *Lygodium japonicum* (Thunb.) Swartz, J. Bot. 1800 (2)" 106 (1801) (Fig. 2C) (Lygodiaceae)

Characteristics of species: Plant terrestrial, climber; rhizome creeping, dichotomously branched, clothed with dark brown hairs. Pinnae on frondlets range from triangular to deltoid in form, with short stalks, double serrated pinna margins.

Uses: Extensively used in gardening and landscaping for its decorative foliage and climbing habit; traditionally young leaves and stems used in salads or cooked as a vegetable[9].

Distribution: Species is native to Tropical & Subtropical Asia (including Bhutan) to Caroline Islands

Collection locality: Pepchu under Talo gewog.

4. *Athyrium drepanopteron* (Kunze) Milde A. Braun ex Milde, Fil. Eur. 49 (1867) (Fig. 2D) (Woodsiaceae)

Characteristics of species: Plant terrestrial. Rhizomes short, ascending, apex densely clothed with brown subulate lanceolate scales. Frond unipinnate- pinnatifid, basal pinnae not shortened and densely scaly; pinnules ovate-oblong, dentately serrated and recurved. Sori small, placed at the forking of the veinlets; indusium more or less reniform.

Uses: Very good soil stabilizer and prevent erosion also used in gardening and landscaping for its decorative foliage.

Distribution: Species is native to Himalaya to China, Sumatera, Philippines (including Bhutan)

Collection locality: Shongrina under Talo gewog.

5. *Diplazium esculentum* (Retz.) Swartz, J. Bot. (Schrader). 1801(2): 312 (1803) (Fig. 2E) (Woodsiaceae)

Characteristics of species: Plants mesophytic, terrestrial, erect; rhizome long, creeping, scaly. Basal 2-3 pairs of veinlets of adjacent lobes fuse to form an irregular excurrent veinlet, runs to the sinus.

Uses: It is one of the most popular vegetables consumed in different parts of the globe[10].

Distribution: Species is native to Tropical & Subtropical Asia (including Bhutan) to SW. Pacific

Collection locality: Thara under Guma gewog.

6. *Diplazium maximum* (D. Don) C. Christensen, Index Filic. 235. (1905) (Fig. 2F) (Woodsiaceae)

Characteristics of species: Plants mesophytic and terrestrial. Rhizome creeping with dense loose scales at apex. Basal vein lets of adjacent lobes do not fuse to form an irregular excurrent veinlet. Pinnule lobes slightly ascending, contiguous or approximate, oblong or subrectangular, shallowly crenate or entire, apex rounded; Sori linear, up to 6 pairs per lobe,; Spores bean-shaped, without perispore.

Uses: Use as vegetable and root paste applied for cure of Bone fracture[11].

Distribution: Species is native to Afghanistan to Temp. E. Asia (including Bhutan) and Philippines. Sulawesi.

Collection locality: Thara under Guma gewog.

7. *Dryopteris cochleata* (Buchanan-Hamilton ex D. Don) C. Christensen, Index Filic. 258. (1905) (Fig. 2G) (Dryopteridaceae)

Characteristics of species: Plants lithophytic, erect. Fronds approximate, dimorphic. Pinnules (segments) 10-12 pairs, oblique, oblong or subfalcate, margin incised-serrate, apex obtuse. Sori globose, indusiate, dark- brown, in two rows, on either side of costules.

Uses: The juice of young fronds is used to treat muscular and rheumatic pain[12]. People

residing in Himalaya also used tender leaf of this species as vegetable[13].

Distribution: Species is native to Tropical & Subtropical Asia including Bhutan.

Collection locality: Thara under Guma gewog.

8. *Nephrolepis cordifolia* (Linnaeus) C. Presl, Tent. Pterid. 79. (1836) (Fig. 2H) (Nephrolepidaceae)

Characteristics of species: Sometimes it grows as an epiphyte on tree ferns, a medium-sized terrestrial to lithophytic fern. Rhizome: erect, short, narrowly lanceolate scales, yellowish brown. Pinnae 40–100 pairs, lamina linear–lanceolate or narrowly lanceolate. lanceolate, with an uneven base, a sharp auricle, and a serrated to crenate edge. lunulate-reniform sori; brown, elongated indusia.

Uses: The species is extensively used in flower wreath-making as well as used locally in gardens as a hedge plant. Young leaves are cooked as vegetable[14]. Fresh tubers are roasted and consumed by the native Himalayan tribes[15].

Distribution: Species is native to São Tomé, SW. Cameroon, W. Indian Ocean, Tropical & Subtropical Asia (including Bhutan) to Pacific.

Collection locality: Logodama, Semtogangchu under Guma gewog and Nobgang under Talo gewog.

9. *Davallia trichomanoides* Blume, Enum. Pl. Javae 2: 238 (1828) (Fig. 3A) (Davalliaceae)

Characteristics of species: Both epiphytic and lithophytic plants are pendent; their rhizomes are broad, creeping, scaly, and have brown or reddish-brown scales. Pinnae pinnae deltoid; pinnules narrowly elliptical; fronds tripinnate; lamina complex, tripinnate or quadripinnate; At the point where veins fork, soror detach and are often solitary on a segment; indusium is also attached to the sides and is oblong and pouch-shaped.

Uses: The species is among **o**ne of the more commonly used ferns in a terrarium[16].

Distribution: Species is native to Tropical & Subtropical Asia (including Bhutan) to N. Australia.

Collection locality: Thara and Semtogangchu under Guma gewog.

10. *Hemionitis albomarginata* (C.B.Clarke) Christenh., Global Fl. 4: 9 (2018) [Syn. *Aleuritopteris albomarginata* (Clarke) Ching] (Fig. 3B) (Pteridiaceae)

Characteristics of species: Lithophytic plant; Short, erect rhizomes; black and broad, bicolor scales; clustered flowers oblong-deltoid to deltoid lamina; pinnae three to five pairs, sessile, unique along the rachis; Sori are up of many sporangia that confluence when fully grown; False wide, frequently interrupted, almost to the midvein, with fimbriate borders.

Uses: Used as ornamental and also used as a general tonic for children and weak people[17].

Distribution: Species is native to Indian Subcontinent to S. China and Indo-China (including Bhutan), Taiwan to Philippines

Collection locality: Pepchu under Guma gewog.

11. *Hemionitis bicolor* (Roxb.) Christenh., Global Fl. 4: 10 (2018) [Syn. *Aleuritopteris bicolor* (Roxburgh) Fraser-Jenkins] (Fig. 3C) (Pteridiaceae)

Characteristics of species: terrestrial lithophytic plants. Rhizomes upright or ascending; concolorous, brown to black scales many, grouped fronds; Lamina with a range of shapes, from pinnate to tripinnatifid; Sessile or subsessile pinnae, with at least some of them frequently having a somewhat falcate shape, and sporangia-filled sores; False Indusia, dark, grayish brown, herbaceous or membraneous

Uses: The leaf of this species is swallowed to settle stomach upsets in villages[18].

Distribution: Species is native to Indian Subcontinent (including Bhutan) to W. Malaysia to W. Malaysia.

Collection locality: Pepchu under Guma gewog.

12. *Adiantum incisum* Forssk., Fl. Aegypt.-Arab.: 187 (1775) (Fig. 3D) (Pteridiaceae)

Characteristics of species: Plants lithophytic; Rhizome short; Fronds tufted, arching, membranous; lamina linear to cultrate; pinnate, attenuate; pinnae mostly oblong, but reduced and obcuneate towards apex of frond; Sori borne at apices of pinna lobes; indusial flaps lunate to oblong, glabrous to thinly pilose.

Uses: The species is widely used traditionally as remedy in different disease conditions like, fever, inflammation and skin disease[19].

Distribution: Species is native to Africa, Arabian Peninsula Indian Subcontinent to China (including Bhutan).

Collection locality: Thara under Guma gewog.

13. *Adiantum philippense* subsp. *philiphense* Fraser-Jenkins, Tax. Revi. Of Three Hundreed Ind. Subcon. Pterid. With a revi. Cen. List 578. (2008) (Fig. 3E) (Pteridiaceae)

Uses: The species is provides microhabitat of zooplankton and mollusks.

Characteristics of species: Plants lithophytic; erect, short rhizomes with dark brown scales; grouped flowers; lamina 1-pinnate; alternating, obliquely spreading pinnules in pairs of six to twelve; sori 2–5, along the edge, linear, flase indusium, fully brown.

Distribution: Species is native to Tropical & Subtropical Asia including Bhutan

Collection locality: Logodama and Semtogangchu under Guma gewog.

14. *Adiantum incisum* subsp. *incisum* Forssk. In: Fl. Aeg. -Arab. 187(1775). (Fig. 3F) (Pteridiaceae)

Characteristics of species: Plants lithophytes. Lower pinnae not usually larger than the rest and often somewhat reduced, pinnae basally dimidiate, rhombic.

Uses: The species is provides microhabitat of zooplankton and mollusks.

Distribution: Species is native to Africa, Arabian Peninsula Indian Subcontinent to China (including Bhutan)

Collection locality: Logodama under Guma gewog.

15. *Pteris grandifolia* L., Sp. Pl.: 1073 (1753) (Syn. *Pteris vittata* Schkuhr) (Fig. 3G) (Pteridiaceae)

Characteristics of species: Terrestrial lithophytic plants. Lanceolate scales. Tucked in front. The lowest pinnae are 3–4 cm apart, decumbent, sessile, and not connate with rachises. The basal pair of pinnae is the shortest in size. The lamina is 1-pinnate, oblanceolate-oblong. Lateral pinnae can reach 40 pairs, alternate or occasionally subopposite.

Uses: This species is effectively used for the remediation of soils and groundwater contaminated like Arsenic[20].

Distribution: Species is native to Florida to Caribbean, Mexico to Venezuela and Bolivia, Subtropical Asia including Bhutan.

Collection locality: Chendheygang under Guma gewog.

16. *Pteris biaurita* subsp. *walkeriana* Fraser-Jenk. & Dominic Rajkumar; Tax. Revi. Of Ind. Subcon. Pterid. 115 (2008) (Fig. 3H) (Pteridiaceae)

Characteristics of species: Plants terrestrial; Rhizome erect covered with brown scales; Fronds clustered; Lamina 2- or 3-pinnatipartite, oblong-ovate; lateral pinnae 8-10 pairs, decumbent, opposite; asal pair of pinnae often each with 1 or sometimes 2

pinnules, segments 20-25 pairs; Indusia light brown, membranous, entire, persistent.

Uses: It is used for ornamental purposes and also popularly consumed as vegetables[13].

Distribution: Species is native to Tropical & Subtropical Asia including Bhutan

Collection locality: Logodama under Guma gewog.

17. *Pteris wallichiana* Agardh, Recens. Spec. Pter. 69. (1839) (Fig. 4A) (Pteridiaceae)

Characteristics of species: Lithophytic plants with erect, short rhizomes and ovate-lanceolate scales. Pedates ferns;Lamina is often three-partite, with separate veins that may fork once or twice, a merged basal pair, and a present costal areole. Glabrous costule. Pinnatipartite, with more than 20 pairs of lateral pinnae, a terminal pinna that resembles the lateral pinnae, a cuneate base with a short stalk, and conspicuous, glabrous, slightly grooved, adaxially prominent costules with short spines.

Uses: It has been *used* as food and medicine in folk for gastrointestinal diseases[21].

Distribution: Species is native to Tropical & Subtropical Asia including Bhutan

Collection locality: Thara, Bebigarkha and Logodama under Guma gewog.

18. *Onychium vermae* Fraser-Jenkins & Khullar in Fraser-Jenkins, Kandel, & Pariyar, Ferns and fern-allies of Nepal 1:300 (2015) (Fig. 4B) ((Pteridiaceae)

Plants terrresterial. Fronds quadripinnate. Pinnae alternate. Basal pinnae tripinnate. Ultimate segments stalked or sessile.

Uses: Used as ornamental fern

Distribution: Species is native to Pakistan to S. Central China, including Bhutan

Collection locality: Thara and Bebigarkha under Guma gewog.

19. *Phegopteris aurita* (Hook.) J. Sm., Cat. Cult. Ferns: 17 (1857) [Syn. *Thelypteris aurita* (Hooker) Ching] (Fig. 4C) (Thelypteridaceae)

Characteristics of species: Plants Lithophytic. Fronds uni-pinnate to bipinnate. Pinnae deeply lobed with segments. Basal basiscopic pinnules/segment larger than acroscopic segment.

Uses: The dried leaves extensively used for making bedding for poultry which act as an insecticide[22].

Distribution: Species is native to Tropical & Subtropical Asia including Bhutan

Collection locality: Thara under Guma gewog.

20. *Thelypteris cana* (Baker) Ching, Bull. Fan Mem. Inst. Biol. 6 (5): 291 (1936) (Fig. 4D) (Thelypteridaceae)

Characteristics of species: Lithophytic plants. Rhizome upright but subordinate. Fronds gathered together. Whole segments; oblong-lanceolate laminae; pinane pairs longer than 15 cm. pinnate-pinnatifid; proximal pair of segments slightly elongate, spreading; middle pinnae narrowly lanceolate, pinnatifid, and long acuminate Laminae, when dry, dark green or greenish, thinly papery or herbaceous. Indosia orbicular-reniform, brown, persistent, and hairy; sori orbicular, attached on middle veinlets.

Uses: This fern is good indicator of acidic soil.

Distribution: Species is native to Pakistan to Indo-China including Bhutan

Collection locality: Logodama under Guma gewog.

21. *Thelypteris arida* (Don) Morton, Amer. Fern J. 49:113 (1959) (Fig. 4E) (Thelypteridaceae)

Characteristics of species: Plants lithophytic, Rhizomes long creeping; Scales ovate-lanceolate; lamina bases abruptly or gradually narrowed, apices caudate to acuminate; pinnae 15-40 pairs, middle pinnae

linear-lanceolate. Laminae papery to somewhat leathery, brownish green or yellowish green when dried. Sori orbicular, medial; indusia glandular, sometimes hairy

Uses: It can be used for biofuel production, environmental remediation, and in the rainforest ecosystem[23].

Distribution: Species is native to Tropical & Subtropical Asia (including Bhutan) to SW. Pacific

Collection locality: Dapcheygang under Guma gewog.

22. *Microlepia platyphylla* (D. Don) J. Smith, London J. Bot. 1: 427 (1842) (Fig. 4F) (Dennstaedtiaceae)

Characteristics of species: Terrestrial plants. With dense, subulate, dark reddish-brown bristles, the rhizome creeps. When dried, the lamina is yellow-green, bipinnate, and broadly triangular in shape. Both surfaces are glabrous, with the exception of the thick, short, light brown hairs on the rachillae. Sori 2–5 per lobule, large and orbicular; indusium brown, large, membranous, and complete, orbicular-reniform.

Uses: The species is widely used for making paper, as an ornamental plant, and for erosion control.

Distribution: Species is native to Indian Subcontinent to Philippines and Indo-China including Bhutan

Collection locality: Dongkokha under Talo gewog.

23. *Selliguea capitellata* (Mett.) X.C.Zhang & L.J.He, Taxon 67: 244 (2018) [Syn. *Arthromeris wallichiana* (Spreng) Ching] (Fig. 4G) (Polypodiaceae)

Characteristics of species: Golden-brown scales; lithophytic to epiphytic plants. The entire rhizome is densely covered in brown scales; the lamina is rectangular and imparipinnate; the pinnae are typically 5-8 pairs, subopposite, ovate-lanceolate, with an entire or undulating border and acuminate apex. Pinnae sessile and subopposite. Large, exindusiate, globose-orbicular sorors in a row on both sides of the costa.

Uses: Tender young fronds cooked and used as a vegetable[24].

Distribution: Species is native to Himalaya to S. Central China and Indo-China including Bhutan

Collection locality: Shongrina under Talo gewog.

24. *Drynaria propinqua* (Wallich ex Mettinues) Smith, apud Beddome, Ferns Brit. India: t.160. (1866) (Fig. 4H) (Polypodiaceae)

Characteristics of species: Plant epiphytic to lithophytic, coriaceous. Rhizome rather long creeping; Fronds dimorphic, glabrous; basal fronds orbicular or ovate sterile nest leaves; lamina pinnatifid; pinnae 7-15 pairs, margin dentate, apex acute. Sori in 1 regular row between costa and margin, close to costa. Spores verrucate.

Uses: Paste of the rhizome is applied to treat backache and dislocated bones[25] (Malla et al, 2015). The Monpa tribe of Arunachal Pradesh used the extract of the rhizomes as an antidote against toxicities caused by food and meat poisoning[26].

Distribution: Species is native to Himalaya to S. Central China and Indo-China (including Bhutan), Jawa

Collection locality: Pepchu under Guma gewog.

25. *Goniophlebium lachnopus* (Wall. ex Hook.) Bedd., Ferns Brit. India: t. 163 (1866) [Syn. *Polypodiodes lachnopus* (Wallich *ex* Hooker) Ching], (Fig. 4I) (Polypodiaceae)

Characteristics of species: Plants epiphytic to lithophytic. Rhizome densely covered with scales, Scales black, ovate-lanceolate, margin ciliated, and Lamina pinnatipartite, linear-lanceolate in outline, papery or herbaceous.

Veins distinct, forming a single row of costal aerole. Sori orbicular, in 1 row on each side of costa, medial.

Uses: Use as ornamental plant.

Distribution: Species is native to Himalaya to China (including Bhutan) and N. Thailand.

Collection locality: Logodama under Guma gewog.

Discussion

Only roughly 8 percent of the 25 species of Pteridophytes that have been identified are epiphytes. Since epiphytes are persistent habitat indicators (Della and Falkenberg, 2019), an area's epiphyte abundance and richness indicate the presence of a suitable climate and environmental conditions that are present there. The low epiphyte percentage indicates a small level of pollution in the research area. This is because pteridophytes' native habitats are being disrupted by growing populations, visitors, and deforestation.

The major part of inhabitants are rural people, and their main occupation is agriculture. Major land covered with pteridophytes is burned to extend the agricultural land. Villagers depend directly on forest resources, including pteridophytes, for maintaining their needs like food, fodder, medicine, and household items. During the survey period in the area, it was observed that young fronds of *Diplazium esculentum* and *Diplazium maximum* are extensively collected and sold in the market as a vegetable by the locals, which provides off-farm income in subsistence of their livelihood. Local people were also found to be using rhizomes of *Dryopteris cochleata* for the treatment of wounds, ulcers, and swellings, as it has antimicrobial and antioxidant properties. *Hemionitis albomarginata* and *H. bicolor* were seen as remedies for nose rhinitis.. *Pteris wallichiana* is used as animal bedding, where it is mixed with dung to produce good manure. Most of the peridophytes are used as fodder. These species of pteridophytes are only exploited; no steps are taken for their regeneration. Therefore, it's vital to initiate the conservation approaches for these pteridophytes in the study area.

4. **Conclusion:** In conclusion, the scant distribution of epiphytic pteridophytes in the investigated region underscores the effects of human activity on these important species in addition to reflecting ecological conditions. Pteridophytes are essential to local populations' ability to maintain their way of life because they provide them with food, medicine, and other resources. However, there are serious risks to their survival and regeneration from overharvesting and habitat disruption brought on by agricultural growth. Effective conservation methods must be put into place to guarantee both the natural health of the area and the availability of these priceless species in the future. In order to promote a balance between community needs and environmental preservation, these initiatives should concentrate on sustainable harvesting practices, habitat restoration, and increasing understanding about the ecological significance of pteridophytes.

Author contributions:

KC done the field-work, collection, conceptualization, and manuscript writing; **PKV** done review and editing.

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References

1. Della AP, Falkenberg DB. Pteridophytes as ecological indicators: an overview. *Hoehnea*, 2019; 46:e522018. http://dx.doi.org/10.1590/2236-8906-52/2018

2. Hassler, M. Checklist of ferns and lycophytes of the world. 2018; version.7.4.

3. Fraser-Jenkins CR, Matsumoto S, Wangdi T. Pteridophytes of Bhutan – A list of families, genera and species. National Biodiversity Centre, Ministry of Agriculture and Forests, Thimphu, Bhutan, 2009; 125pp.

4. Dorji R, Thomas MB. Pteridophytes of Bhutan. Bhutan Biodiversity Portal. 2017; Accessed 15 Sep 2019. https://doi.org/10.47811/bhj.63

5. Fraser-Jenkins CR, Matsumoto S, Wangdi P. Pteridophytes of Bhutan–A Taxonomic Enumeration. M/S Bishen Singh Mahendra Pal Singh, Dehradun. 2023; pp. 610.

6. Kholia BS. Ferns and Fern-allies of Sikkim, A Pictorial Handbook, Part 1. Sikkim Biodiversity Board. 2011; pp. 130.

7. Demarco CF, Afonso TF, Pieniz S, Selau FC, Machado F, Andreazza R. Potential Phytoremediation of Aquatic Macrophyte Species for Heavy Metals in Urban Environments in the Southern Area of Brazil. Sustainability, 2022; 15(1):419. https://doi.org/10.3390/su15010419.

8. Husby CH, Delatorre J, Oreste V, Oberbauer SF, Palow DT, Novara L, Grau A. Salinity tolerance ecophysiology of Equisetum giganteum in South America: a study of 11 sites providing a natural gradient of salinity stress, AoB PLANTS, 201; plr022, https://doi.org/10.1093/aobpla/plr022.

9. EPPO, Data sheets on pests recommended for regulation. Lygodium japonicum (Thunb.) Sw. *Bulletin OEPP/EPPO Bulletin*. 2019; 49(2), 261–266.

10. Konsam S, Thongam B, Handique A K. Assessment of wild leafy vegetables traditionally consumed by the ethnic communities of Manipur, northeast India. *J Ethnobiol Ethnomed*., 2016; 12(1):p. 9. https://doi.org/10.1186/s13002-016-0080-4.

11. Rai PK, Lalramnghinglova H. Lesser known ethnomedicinal plants of Mizoram, North East India: An Indo-Burma hotspot region, *J Med Plants Res*., 2010; 4(13): 1301-1307.

12. Parihar P, Leena P, Achaleshwar B. In vitro antibacterial activity of fronds (leaves) of some important pteridophytes. *J Microbiol Antimicrob*., 2010; 2(2):19–22.

13. Bajracharya GB, Bajracharya B. A comprehensive review on Nepalese wild vegetable food ferns. *Heliyon*., 2022; 8 (11): e11687. https://doi.org/10.1016/j.heliyon.

14. Mary FJ, Senthil Kumar M, Leelavathi A, Lokesh M, Mahalakshmi M, Masoor Ahmed MB, Meganathan A. Nephrolepis cordifolia: A Review on the fern. *Journal of University of Shanghai for Science and Technology*, 2021; 23 (10): 301-305.

15. Gauchan DP, Manandhar D, Shrestha N, Suwal SK. Nutrient Analysis of Nephrolepis cordifolia (L.) C. Presl. *Kathmandu University Journal of Science, Engineering and Technology*. 2008; 1(5):68-72

16. Meliza R, Chikmawati T, Sulistijorini S. Morfologi Spora Dan Perkembangan Gametofit Davallia denticulate, dan Davallia trichomanoides *Journal Bioteknologi Biosains Indonesia*. 2019; 6(1): 1–10. https://doi.org/10.29122/jbbi.v6i1.2607

17. Parihar P, Parihar L. Some pteridophytes of medicinal importance from Rajasthan. *Natural Product Radiance*. 2006; 5(4): 297-301.

18. Fraser-Jenkins CR, Kandel DR, Pariyar S. Ferns and Fern-allies of Nepal National Herbarium and Plant Laboratories, Department of Plant Resources, Ministry of Forests and Soil Conservation, Kathmandu, Nepal. 2015; pp. 1-492.

19. Goyal PK, Singh GA. Comprehensive Review on Adiantum incisum (Maidenhair). *RRJoDFDP*. 2023; 8(03):1-8. https://journals.stmjournals.com/rrjodfdp/

20. Fayiga, A.O. and Saha, U. K. (2016). Arsenic hyperaccumulating fern: implications for remediation of arsenic contaminated soils. *Geoderma*, 284: 132-143.

21. Pei J. Chinese Medicinal Plants; Science Press: Beijing, China. 1955; 1: 547–548.

22. Ghosh G. Role of Plant bioresources in Traditional Health care system: A case study from the Upper Siang District of Arunachal Pradesh, India. *Indian J. Applied & Pure Bio*., 2021; (Spl)2(1): 241-249.

23. Jamal Uddin M, Nawrin F, Jahan MR, Jahir S, Ahmed A, Zulfiqar R. Phytochemical Screening and In-Vitro studies of Thelypteris arida Leaves: An Experimental Study. *Chin J Med Hist*., 2023; 53(8):1471-1483.

24. Manandhar NP. Plants and people of Nepal. Timber Press, USA. 2002; pp.599.

25. Malla B, Gauchan DP, Chhetri RB. An ethnobotanical study of medicinal plants used by ethnic people in Parbat district of western *Nepal. J Ethnopharmacol*., 2015; 165:103–17. https://doi.org/10.1016/j.jep.2014.12.057

26. Tsering J, Tag H, Gogoi BJ, Veer V. Traditional anti-poison plants used by the Monpa tribe of Arunachal Pradesh. In: Herbal insecticides, repellents and biomedicines: effectiveness and commercialization. New Delhi: Springer. 2016; p. 189–203.