Inventory of Ferns and Fern Allies of Raja-Rani Wetland and Adjoining Forest, Eastern Nepal

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Abstract

Pteridophytic flora of Raja-Rani wetland area occurring in the churia range was studied in pre monsoon 2019 to post monsoon 2020. A total of 50 species of ferns and fern allies belonging to 19 families and 32 genera were recorded. Pteridaceae was the largest family with 13 species and *Thelypteris* was the largest genus with five species. Occurrence of the fern species inareawas in the order: terrestrial (60%) > lithophytic (18%) > epiphytic (10%) > aquatic (6%) and climbers (6%). Nine species were threatened and *Huperzia phlegmaria* (L.) Rothm. & *Lindsaea ensifolia* Sw. were rare species new to Eastern, Nepal.

Keywords: *Angiopteris helferiana*, Endangered, Epiphytes, Letang, *Oeosporangium belangeri*

Introduction

Ferns along with fern allies are an integral part of the world vegetation. They are non-flowering leafy or leafless vascular plants generally found in moist and shady places of tropical to alpine climate. Ferns are considered as the oldest vascular plant to become dominant on the earth about 299-369 million years ago (Carboniferous Period), now they are replaced by Angiosperms and Gymnosperms (Rothwell & Stockey, 2008). They have varied habits like terrestrial, epiphytic, aquatic, lithophytic (Gurung, 1991). They are also being used as an important source of vegetable, medicine, fodder, ornamental plants in different parts of the world including Nepal (Dangol, 2002; Rout et al., 2009). There are about 12000 species of pteridophytes in the world (Christenhusz & Byng, 2016). In Nepal, 582 taxa (550 species and 32 subspecies) of ferns and fern allies are found (Kandel & Fraser-Jenkins, 2020).

In National Herbarium and Plant Laboratories, Nepal (KATH) about 18,000 specimens of the Pteridophytes have been preserved and greatest number of collection is confined to central Nepal (Kandel, 2020). Three ferns *viz., Asplenium pseudofugax*, *Bolbitis andreisii* and *Polystichum annapurnicola* are endemic to Nepal (Fraser-Jenkins et al., 2015; Fraser-Jenkins & Kandel, 2019; Kandel & Fraser-Jenkins, 2020). The maximum species richness of pteridophytes is found in central Nepal at an altitude of 2000m (Bhattrai et al., 2004).

Eastern region of Nepal being rich in plant diversity also lacks major studies in the pteridophytes. Some of the literature regarding pteridophytes of eastern Nepal are: Siwakoti & Sharma, (1998); Jha, (2000); Thapa, (2001); Bhagat & Shrestha, (2010); Pathak et al., (2012) etc. Present work is preliminary exploration of fern and fern allies along with their ecology and status from the Raja-Rani wetland and adjoining forest located in Letang Municipality of Morang District Eastern Nepal.

Materials and Methods

Study Area

Raja-Rani wetland (26°45'21" N, 87°29'10"E, Altitude 470 m) is situated in the Letang Municipality-1, Morang District in chure range of Province-1, Nepal (Figure 1). It is protected under Raja-Rani community forest (17 sq. km.), which harbors three ponds *viz.,* Raja, Rani, and Rajkumari altogether covering 0.2 sq. km (Basnet et al., 2005). The wetland area is an important religious and historic place for Dhimal tribes surrounded by *Shorea robusta* dominated dense mixed forest associated with *Adina cordifolia*, *Cassia fistula*, *Semecarpus anacardium, Anthocephalus cadamba* etc (Chettry, 2017).

The climate of the study area is hot and humid during the summer, having rich monsoon rain and cold dry winters. The average annual maximum and minimum temperature ranges from 12°C-19°C and 22°C-30°C respectively. The annual rainfall of the region varies from 1,138mm to 2,671mm (Godar & Rai, 2018). The area is passing through socioeconomic changes like infrastructural development, tourism andrecreations.

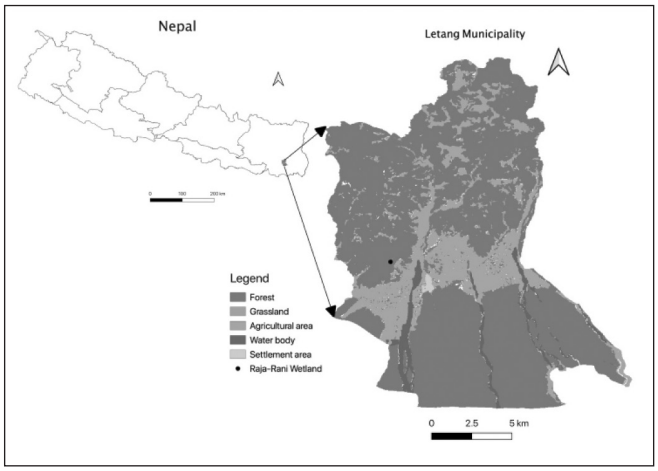

Figure1: Raja-Rani wetland in the map of Letang Municipality, Nepal.

Plant collection and Identification

The present work is based on regular field visits, herbarium collection, field notes, photography, and identification. Several field visits were conducted during the pre-monsoon of 2019 to post-monsoon of 2020. Mature fronds of the plants along with sori were gently cut and in the case of small plants, whole plants were collected from around 50m of the bank of the pond area. The photographs of the plants in natural habitat and after collection were taken. A boat was also used to collect the plants of wetland area. The collected plants were placed in between newspaper, pressed for several days with frequently changing paper usedand after got dried mounted on herbarium sheets with labeling. Identification and notes on status (Distribution status and Threaten status) of the collected specimens were done using Fraser-Jenkins et al., (2015), Fraser-Jenkins & Kandel, (2019), Kandel & Fraser-Jenkins, (2020) etc. Herbarium specimens were deposited in the Tribhuvan University Regional Herbarium, Department Botany, Post Graduate Campus, T.U., Biratnagar. Most of the specimens were identified in National Herbarium and Plant Laboratories, Godawari (KATH).

Results and Discussion

In the present study, 50 species of ferns and fern allies belonging to 19 families and 32 genera were reported from the study area (Appendix 1). Two species *Huperzia phlegmaria* and *Lindsaea ensifolia* were new to Eastern Nepal. Six species were fern allies and the rest were ferns. Among 19 families, Pteridaceae was the largest family (13 species) followed by Polypodiaceae (6 species), Thelypteridaceae (5 species). Lomariopsidaceae, Lycopodiaceae & Lygodiaceaehad (3 species) in each and Dryopteridaceae, Lindaeceae, Selaginellaceae & Woodsiaceaehad (2 species) in each. Aspleniaceae, Blechnaceae, Cyatheaceae, Dennstaedtiaceae, Equisetaceae, Gleicheniaceae, Marattiaceae, Salvinaceae and Vittariacaeaehad single species in each (Figure 2).

The largest genus was *Thelypteris* (5 species) followed by *Pteris* and *Pyrrosia* (4 species) in each. Most of the species were terrestrial (60%) followed by lithophytic (18%), epiphytic (10%), aquatic (6%) and climbers (6%) respectively (figure 3). No species were found in more than one habit.

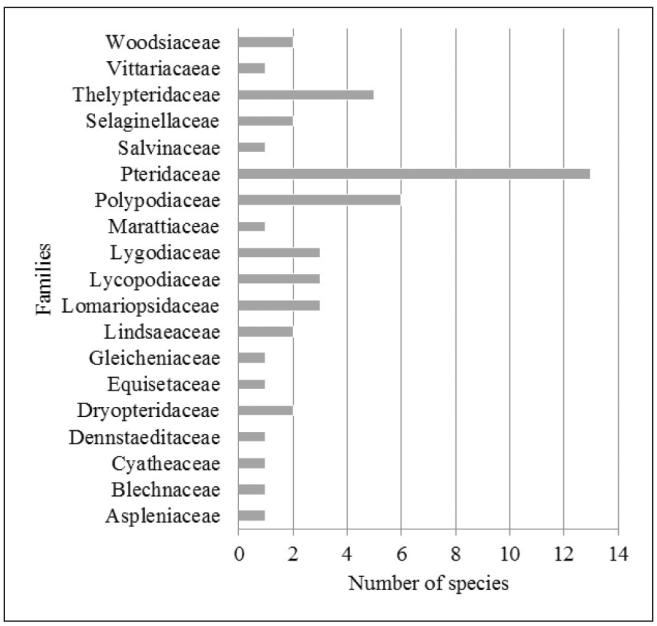

Figure 2: Number of species among the families in Raja-Rani, Letang.

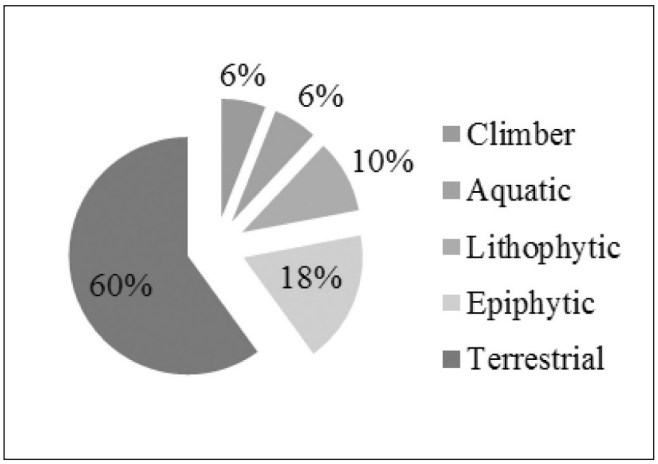

Figure 3: Habit of Ferns and Fern Allies in Raja-Rani, Letang.

Nine threatened ferns and fern allieswere reported from the area. One species *Lygodium microphyllum* is critically endangered, three species (*Huperzia phlegmaria, Lindsaea ensifolia* and *Oeosporangium belangeri*) are endangered, two species (*Pteris semipinnata* and *Thelypteris interrupta*) are vulnerable, two species (*Angiopteris helferiana* and *Cyathea spinulosa*) are least concerned and one species *Huperzia squarrosa* is nearly threatened. *Cyathea spinulosa* is a CITES appendix II listed fern and *Oeosporangium belangeri* is one of the rarest fern of Nepal (Joshi et al., 2017; Kandel, 2020).

Diplazium esculentum and *Dryopteris cochleata* were locally used as vegetable. *Aleuritopteris bicolor, Angiopteris helferiana, Blechnum orientale, Cyathea spinulosa*, *Dynaria quercifolia, Lygodium japonicum, Lygodium flexuosum, Pteris biaurita, Pityrogramma calomelanos* and *Tectaria coadunata* were medicinal ferns (Gurung, 1979; Pathak et al., 2012).

Sharma et al., (2020) reported 10 species of ferns from Raja-Rani wetland Letang, among them two species *Azolla pinnata* subsp. *asiatiica* and *Thelypteris interrupta* (Synonym *Cyclosorus interruptus*) were aquatic. Beside these species, present study reported one morecommon aquatic fern *Ceratopteris thalictroides* from the area.Two species of ferns *Microlepis setosa* (Sharma et al., 2020) and *Drynaria coronans* (Kandel & Fraser-Jenkins, 2020) were not reported from the area.

Conclusions

In about 0.3 sq. km., 50 species of ferns and fern allies were reported and two of them were new to the eastern Nepal. The area has a high diversity of ferns and fern allies with number of threatened species requiring urgent need for conservation strategies. Further studies are also inevitable for biodiversity management strategies in the Raja-Rani wetland and adjoining forest area of Letang municipality, Morang.

Author Contributions

The first author conducted field visits, prepared herbariums, identified specimens, and prepared manuscript. Second author designed the study, helped in identification & manuscript preparation and supervised the work.

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Table 1 : Distribution and occurrence of Pteridophytes from Raja-Rani Morang.

S.N.	Name	Family	Habitat	Threaten Status	Distribution Status
1	*Asplenium obscurum* Blume	Aspleniaceae	Lithophytic	-	C; E: Sunsari, Panchthar.
2	*Blechnum orientale* L.	Blechnaceae	Terrestrial	-	C;E: Solukhumbu, Sankhuwasabha, Morang, Jhapa, Ilam.
3	*Cyathea spinulosa* Wall. ex Hook.	Cyatheaceae	Terrestrial	LC	C; E: Solukhumbu, Sankhuwasbha, Bhojpur, Ilam, Taplejung.
4	*Microlepia speluncae* (L.) T. Moore	Dennstaedtiaceae	Terrestrial	-	C;E: Morang, Jhapa.
5	*Dryopteris cochleata* (D.Don) C.Chr.	Dryopteridaceae	Terrestrial	-	W;C;E: Okhaldhunga, Bhojpur, Sankhuwasabha, Sunsari, Dhankuta, Jhapa, Ilam, Taplejung.
6	*Tectaria coadunata* (Wall. ex Hook. & Grev.) C.Chr.	Dryopteridaceae	Terrestrial	-	W;C;E: Udaypur, Sankhuwasabha, Sunsari, Dhankuta, Ilam, Panchthar, Taplejung.
7	*Equisetum ramosissimum* Desf.	Equisetaceae	Terrestrial	-	W;C;E: Sankhuwasabha, Sunsari, Saptari, Morang, Dhankuta, Taplejung
8	*Dicranopteris lanigera* (D.Don) Fraser-Jenk.	Gleicheniaceae	Terrestrial	-	W;C;E: Okhaldhunga, Khotang, Solukhumbu, Sankhuwasabha
9	*Lindsaea ensifolia* Sw.*	Lindsaeaceae	Terrestrial	EN	C
10	*Odontosoria chinensis* (L.) J.Sm.	Lindsaeaceae	Terrestrial	-	C;E: Bhojpur, Sankhuwasabha, Jhapa, Ilam, Taplejung.
11	*Bolbitis costata* (C.Presl) Ching	Lomariopsidaceae	Lithophytic	-	C;E: Solukhumbu, Jhapa.
12	*Bolbitis heteroclita* (C.Presl) Ching	Lomariopsidaceae	Terrestrial	-	C;E: Jhapa, Sankhuwasabha, Ilam.
13	*Elaphoglossum stelligerm* (Wall. ex Baker) T. Moore ex Salpmon	Lomariopsidaceae	Lithophytic	-	W;C;E: Okhaldhunga, Sankhuwasabha, Dhankuta, Taplejung.
14	*Huperzia phlegmaria* (L.) Rothm.*	Lycopodiaceae	Epiphytic	EN	C
15	*Huperzia squarrosa* (G.Forst.) Trevis.	Lycopodiaceae	Epiphytic	NT	C;E: Sankhuwasabha, Ilam.
16	*Palhinhaea cernua* (L.) Vasc. & Franco.	Lycopodiaceae	Terrestrial	-	C;E: Jhapa, Ilam, Taplejung.
17	*Lygodium flexuosum* (L.) Sw.	Lygodiaceae	Climber	-	W;C;E: Udayapur, Sunsari, Morang, Dhankuta, Sankhuwasabha, Terathum, Jhapa, Ilam, Taplejung.
18	*Lygodium japonicum* (Thunb.) Sw.	Lygodiaceae	Climber	-	W;C;E: Udayapur, Khotang, Bhojpur, Sankhuwasabha, Sunsari, Morang, Dhankuta, Ilam, Taplejung.
19	*Lygodium microphyllum* (Cav.) R.Br.	Lygodiaceae	Climber	CR	E: Morang.
20	*Angiopteris helferiana* C.Presl	Marattiaceae	Terrestrial	LC	C;E: Morang, Jhapa, Ilam.
21	*Drynaria quercifolia* (L.) J. Sm	Polypodiaceae	Epiphytic	-	C;E: Sankhuwasabha, Morang, Jhapa, Ilam.

S.N.	Name	Family	Habitat	Threaten Status	Distribution Status
22	*Microsorum punctatum* (L.) Copel.	Polypodiaceae	Epiphytic	-	C;E: Morang, Jhapa, Ilam.
23	*Pyrrosia costata* (Wall. ex C.Presl) Tagawa & K.I wast	Polypodiaceae	Epiphytic	-	W;C;E: Bhojpur, Sankhuwasabha, Sunsari,Dhankuta, Taplejung.
24	*Pyrrosia lanceolata* (L.) Farw.	Polypodiaceae	Epiphytic	-	W;C;E: Sankhuwasabha, Sunsari, Morang, Jhapa, Ilam, Taplejung.
25	*Pyrrosia nuda* (Giesenh.) Ching	Polypodiaceae	Epiphytic	-	C;E: Bhojpur, Sankhuwasabha, Morang, Dhankuta, Taplejung.
26	*Pyrrosia porosa* (Presl) Hovenkamp	Polypodiaceae	Epiphytic	-	W;C;E: Bhojpur, Sankhuwasabha, Sunsari, Dhankuta, Ilam, Taplejung
27	*Adiantum incisum* Forssk. subsp. *incisum*	Pteridaceae	Terrestrial	-	W;C;E: Udayapur, Okhaldhunga, Bhgojpur, Sunsari, Morang, Dhankuta, Sankhuwasabha, Taplejung.
28	*Adiantum philippense* L.	Pteridaceae	Terrestrial	-	W;C;E: Sankhuwasabha, Sunsari, Morang, Dhankuta, Jhapa, Ilam.
29	*Aleuritopteris bicolor* (Roxb.)	Pteridaceae	Terrestrial	-	W;C;E: Udayapur, Bhojpur, Sankhuwasabha, Sunsari, Morang, Dhankuta, Jhapa, Ilam, Panchthar, Taplejung.
30	*Ceratopteris thalictroides* (L.) Brongn.	Pteridaceae	Aquatic	-	W;C;E: Sankhuwasabha, Jhapa, Taplejung.
31	*Oeosporangium belangeri* (Bory) Fraser-Jenk.	Pteridaceae	Terrestrial	EN	C;E: Sunsari, Jhapa
32	*Oeosporangium tenuifolim* (Burm.fil.) Fraser-Jenk. & Pariyar	Pteridaceae	Terrestrial	-	W;C;E: Khotang, Sankhuwasabha, Solukhumbu, Bhojpur, Jhapa, Ilam
33	*Onychium lucidum* (D.Don) Spreng.	Pteridaceae	Epiphytic	-	W;C;E: Sankhuwasabha, Taplejung
34	*Onychium siliculosum* (Desv.) C.Chr.	Pteridaceae	Terrestrial	-	W;C;E: Udayapur, Okhaldhunga, Bhojpur, Sunsari, Sankhuwasabha, Morang, Dhankuta, Tewrathum, Jhapa, Ilam, Panchthar, Taplejung.
35	*Pityrogramma calomelans* (L.) Link.	Pteridaceae	Terrestrial	-	W;C;E: Sankhuwasabha, Sunsari, Morang, Dhankuta, Jhapa, Ilam, Taplejung.
36	*Pteris biaurita* L.	Pteridaceae	Terrestrial	-	W;C;E: Udayapur, Solukhumbu, Morang, dhankuta, Ilam, Taplejung.
37	*Pteris semipinnata*L.	Pteridaceae	Terrestrial	VU	C;E: Morang, Jhapa.
38	*Pteris venusta* Kunze subsp. *matsudae* (Masam.) Fraser-Jenk. & Kandel	Pteridaceae	Terrestrial	-	W;C;E: Udayapur, Sunsari, Jhapa, Ilam.
39	*Pteris vittata* L.	Pteridaceae	Terrestrial	-	W;C;E: Udayapur, Khotang, Sunsari, Morang, Dhankuta, Sankhuwasabha, Jhapa, Ilam.
40	*Azolla pinnata* R. Br. subsp. *asiatica* R.M.K. Saunders & K. Fowler.	Salvinaceae	Aquatic	-	W;C;E: Bhojpur, Sankhuwasabha, Sunsari, Morang, Taplejung.
41	*Selaginella cillaris* (Retz.) Spring	Selaginellaceae	Lithophytic	-	W;C;E: Siraha, Morang, Taplejung.
42	*Selaginella subdiaphana* (Wall. ex Hook. & Grew) Spring	Selaginellaceae	Lithophytic	-	W;C;E: Sankhuwasabha, Bhojpur, Dhankuta, Siraha, Sunsari, Ilam, Taplejung.

S.N.	Name	Family	Habitat	Threaten Status	Distribution Status
43	*Thelypteris interrupta* (Willd.) K.Iwats	Thelypteridaceae	Aquatic	VU	W;E: Morang.
44	*Thelypteris lakhimpurensis* (Rosenst.) K.Iwats.	Thelypteridaceae	Terrestrial	-	C;E: Ilam.
45	*Thelypteris nudata* (Roxb.) C.V.Morrton	Thelypteridaceae	Terrestrial	-	W;C;E: Sunsari, Sankhuwasabha, Jhapa, Ilam.
46	*Thelypterisornata* (J.Sm) Ching	Thelypteridaceae	Terrestrial	-	W;C;E: Sankhuwasabha, Ilam.
47	*Thelypteris procera* (D.Don) Fraser-Jenk	Thelypteridaceae	Terrestrial	-	W;C;E: Udayapur, Okhaldhunga, Sankhuwasabha, Sunsari, Dhankuta, Morang, Jhapa,Ilam, Panchthar, Taplejung.
48	*Vittaria flexuosa* Fée	Vittariacaeae	Epiphytic	-	W;C;E: Bhojpur, Sankhuwasabha, Solukhumbu, Jhapa, Sunsari, Ilam, Panchthar, Taplejung.
49	*Deparia japonica* (Thunb.) M.Kato subsp. *japonica*	Woodsiaceae	Terrestrial	-	W; C; E: Sankhuwasabha, Ilam, Taplejung.
50	*Diplazium esculentum* (Retz.) Sw.	Woodsiaceae	Terrestrial	-	W;C;E: Sankhuwasabha, Sunsari, Morang, Dhankuta, Panchthar, Taplejung.

Note:* = New report for Eastern Nepal CR= Critically Endangered, EN= Endangered, LC= Least Concerned, NT= Nearly Threatened, VU= Vulnerable, W= Western Nepal, C= Central Nepal, E= Eastern Nepal