The Pteridophytes of Adams, Northern Luzon, Philippines and their Ecosystem Services

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ABSTRACT

The Philippines has approximately 1,100 species of lycophytes and ferns, and this represents approximately 9% of the worldwide fern flora. Botanical explorations and local documentations continue to expand the list. Local documentations increase our knowledge on species distribution and conservation status, which are essential in biodiversity conservation. This paper reports on a survey of the pteridophytes of Adams, Ilocos Norte, one of the remaining floristic sites in Luzon Island, Philippines. A series of floristic surveys conducted at selected sites in Adams recorded and vouchered 47 species, 34 genera and 21 families of pteridophytes. Among all these pteridophytes, six are threatened Philippine plant species. These are *Platycerium coronarium*, *Ceratopteris thalictroides*, *Tectaria psomiocarpa, Psilotum nudum*, *Blechnum egregium*, and *Angiopteris evecta*. This study contributes to the baseline data on Philippine pteridophytes especially on their distribution, and can serve as reference for biodiversity conservation and restoration efforts as ferns may help in the stabilization of degraded lands and facilitation in plant communities.

KEY WORDS :

Pteridology
Ferns
Biodiversity and conservation
Checklist
Ilocos Norte

INTRODUCTION

Pteridophytes, also known as lycophytes and ferns (Smith et al. 2006; PPG I 2016), are spore-bearing vascular plants that are widely distributed in tropical countries, especially in wet forests. There are 11,916 species worldwide (PPG I, 2016), and the number continually increases as discoveries are made. Currently, the Philippines has an estimated 1,100 species of pteridophytes (Amoroso et al. 2016) classified into 3 families of lycophytes and 34 families of ferns (Pelser et al. 2011; Delos Angeles and Buot 2012; Amoroso et al. 2016). The presence of 34 families of ferns in the Philippines out of the 48 families recognized by the Pteridophyte Phylogeny Group I (PPG I, 2016) and all three recognized families of lycophytes (Cristenhusz and Chase 2014; PPG I, 2016) is indicative of the rich pteridoflora of the country. However, given the increasing rate of forest denudation, most of these plants are threatened by extinction. Moreover, a number of pteridophytes are collected from the wild for their economic, medicinal, and aesthetic uses.

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Smith (1841) made a list of Philippine ferns based on the collection of Hugh Cuming. The list contains 297 species that include 207 species from Luzon. The three-volume "Fern Flora of the Philippines" by Copeland (1958a, 1958b, 1958c) records approximately 940 species of ferns in the Philippines. Succeeding inventories of ferns in Luzon Island were made by Price (1975), Iwatsuki and Price (1977), Barcelona (2003), and Catapang et al. (2012).

In this study, a floristic survey of pteridophytes of Adams, Ilocos Norte, northern Luzon, Philippines is presented. Adams is a municipality with only one barangay. It is situated on a mountainous terrain, surrounded with lowland rainforests. Adams is located at the northern tip of the Cordillera Mountain Range, which is one of the few remaining floristic sites in Luzon Island. It has a total land area of 15,931 ha; two parcels of land were declared by the Department of Environment and Natural Resources (DENR) as 'Adams Critical Wildlife Habitats' (DENR Administrative Order No. 2013-23), while other parts of Adams are included within the Kalbario-Patapat Natural Park. Based on the Köppen-Geiger climate classification, Adams has a tropical moist climate, specifically Af or tropical wet, i.e., precipitation occurs all year long. Precipitation varies from approximately 72 mm in March (the driest month) to 373 mm in August (the wettest month) (Pidwirny 1999–2014; Climate-data.org). Being located at a

mountainous area 13.5 km from the main highway, Adams is a place where many wet forests are still undisturbed while few are partly disturbed by scattered residential communities and agricultural activities. The increase in population, agricultural activities, developing tourism and potential forest conversions all pose a threat, not only to the flora but also to the entire biodiversity in Adams.

The flora at the mountainous area of Adams is poorly identified or accounted. Therefore, this study was conducted to provide a preliminary report on the flora, particularly on the diversity of pteridophytes. This local species documentation further contributes to the baseline data of Philippine pteridophytes, especially on their distribution. This study also provides a list of the ecosystem services of the surveyed pteridophytes in the area, based on consultations with the local residents.

METHODOLOGY

Field-surveys of the pteridophytes in Adams (18° 28' N, 120° 55' E), Ilocos Norte, northern Luzon, Philippines were conducted in May 2013, October 2014, March 2016 and February 2017. Five sites were selected, namely, Anuplig (303–311 masl), Inuwayan (224–242 masl) that is divided into A (interior) and B (forest edge), Bolo River (228–240 masl), Lovers' Peak (321–331 masl), and Maligligay (441–490 masl). These sites were selected as they represent a range of vegetation cover, from primary closed canopy forest to secondary forest to degraded/disturbed vegetation cover. Maligligay has a closed canopy primary tropical rainforest. Its ground cover is dominated by saplings/seedlings and the forest litter is thick. Inuwayan and Anuplig are secondary tropical rainforests. Both have steep slopes and thick forest litter; cut through by trails and irrigation pipes. Adjacent to these are patches of citrus, rambutan and cacao groves. There is a piggery adjacent to the forest and stream in Inuwayan. The Bolo River has riparian vegetation, with some wet rice fields along its riverbank. Lover's Peak is the most disturbed area with open/exposed area dominated by low-lying grasses, ferns and some shrubs that serve as grazing ground of cows. This area has a history of slash-and-burn (*kaingin)* activity.

Pteridophytes observed in the area were recorded and photo-documented while some were collected as vouchers for identification. Currently available taxonomic references were used for identification, following the Pteridophyte Phylogeny Group I classification system (PPG I 2016). Bray-Curtis Cluster Analysis was carried out on the data collected from the field-surveys to infer species similarity between sites.

RESULTS AND DISCUSSION

Following the Pteridophyte Phylogeny Group I classification of extant ferns and lycophytes (PPG I 2016), a total of 21 families of pteridophytes were recorded, consisting of 34 genera and 47 species (Table 1). The families and species are listed in Table 2. Pteridaceae has the largest number of species (6) within 5 genera followed by Polypodiaceae and Tectariaceae with 4 species each. Photos of selected species are provided in Figure 1.

Table 1. Total number of genera and species of each family of pteridophyte documented in Adams, Ilocos Norte, Northern Luzon, Philippines

Family	Number of Genera	Number of Species
Aspleniaceae	2	2
Blechnaceae	2	3
Cyatheaceae	1	1
Davalliaceae	1	2
Dennstaedtiaceae	1	1
Dryopteridaceae	2	2
Gleicheniaceae	1	1
Hymenophyllaceae	1	1
Lomariopsidaceae	1	2
Lindsaeaceae	2	3
Lycopodiaceae	1	1
Lygodiaceae	1	3
Marattiaceae	1	1
Polypodiaceae	3	4
Psilotaceae	1	1
Pteridaceae	4	5
Schizaeaceae	1	1
Selaginellaceae	1	3
Tectariaceae	3	4
Thelypteridaceae	4	4
Woodsiaceae	1	2
TOTAL	35	47

This survey presented a checklist of pteridophytes of Adams, northern Luzon following the surveys conducted by Barcelona (2003) and Iwatsuki and Price (1977) in other sites of northern Luzon (Figure 2). Included in this checklist are 21 species previously reported from a survey conducted in Mt. Burnay and its nearby peaks (Iwatsuki and Price 1977) and 12 species in Mt. Baliit, Balbalasang-Balbalan National Park in Kalinga (Balrcelona 2003) (Table 3). The checklist included 35 terrestrial species, 11 epiphytic species, and one aquatic species (Table 2). Most of the epiphytic species were found at the lower part of tree trunks. *Psilotum nudum*, *Asplenium nidus*, and *Platycerium coronarium,* were observed on tree branches and/or upper part of tree trunks. *Ceratopteris thalictroides*, the only aquatic species documented in the area, was observed in low abundance

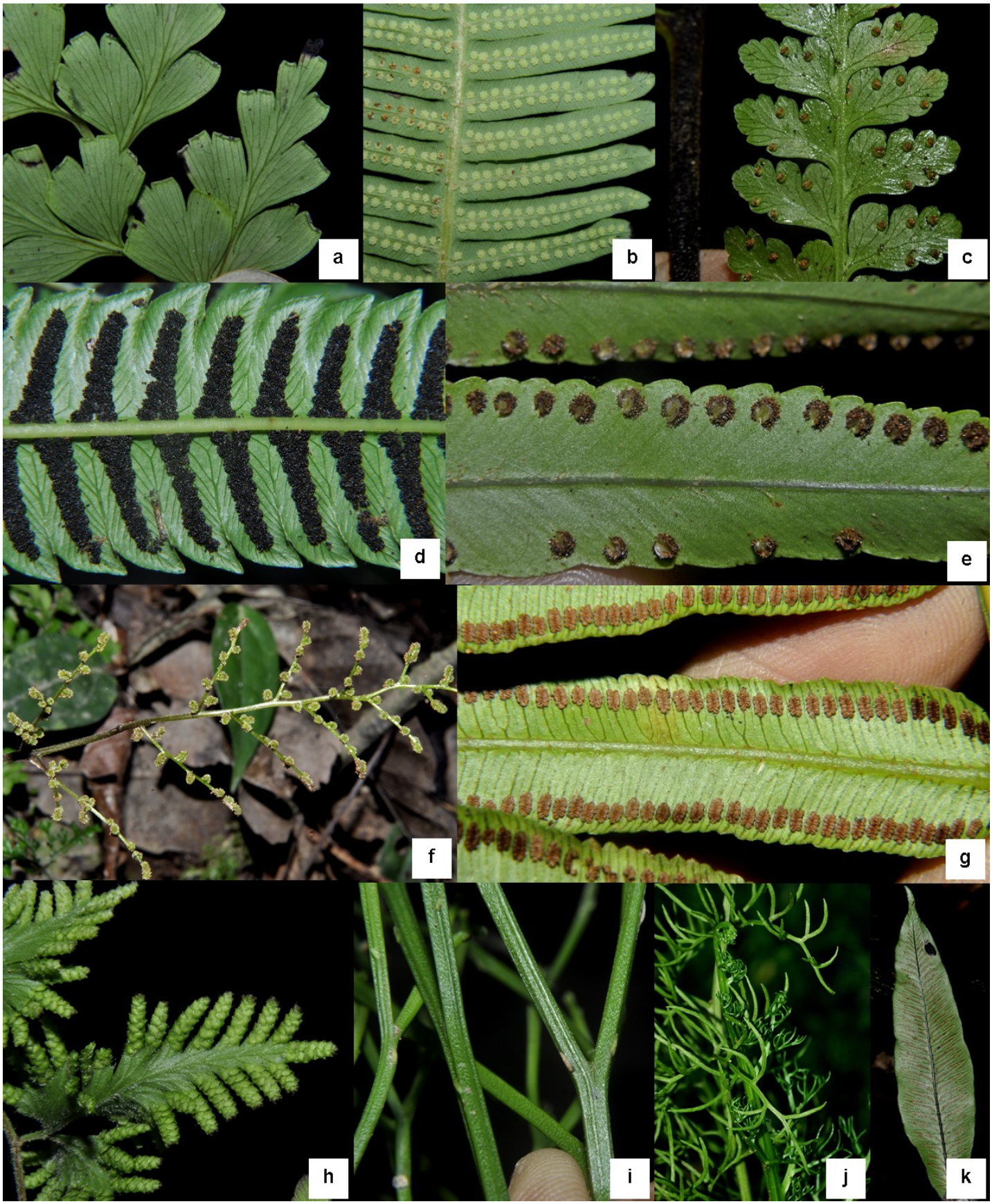

Figure 1. Some species from Adams, Northern Luzon, Philippines. a. *Odontosoria retusa*; b. *Dicranopteris linearis*; c. *Microlepia speluncae*; d. *Chingia ferox*; e. *Nephrolepis brownii*; f. *Tectaria psomiocarpa*; g. *Angiopteris evecta*; h. *Lygodium japonicum*; i. *Psilotum nudum*; j. *Ceratopteris thalictroides*; k. *Diplazium cordifolium*. Scale bars: a–e, g–i, k = 5 mm; f, j = 1 cm

Table 2. Checklist of Adams pteridophytes and their respective growth form.

Family	Species	Growth Form
Aspleniaceae	*Asplenium nidus* L.	Epiphytic
	Asplenium oxyphyllum J. Sm. ex Kunze	Terrestrial
Athyriaceae	*Diplazium cordifolium* Blume	Terrestrial
	Diplazium esculentum (Retz.) Sw.	Terrestrial
Blechnaceae	*Blechnum egregium* Copel. in Perkins	Terrestrial
	Blechnum orientale L.	Terrestrial
	Stenochlaena milnei Underw.	Terrestrial
Cyatheaceae	*Cyathea integra* J. Sm.	Terrestrial
Davalliaceae	*Davallia repens* (L.f.) Kuhn.	Epiphytic
	Davallia heterophylla Sm.	Epiphytic
Dennstaedtiaceae	*Microlepia speluncae* (L.) Moore	Terrestrial
Dryopteridaceae	*Arachniodes amabilis* (Blume) Tindale	Terrestrial
	Bolbitis heteroclita (Presl.) Ching in C. Chr.	Terrestrial
	Ceratopteris thalictroides (L.) Brongn.	Aquatic
Gleicheniaceae	*Dicranopteris linearis* (Burm.f.) Underw.	Terrestrial
Hymenophyllaceae	*Hymenophyllum emarginatum* Sw.	Epiphytic
Lindsaeaceae	*Lindsaea lucida* Blume	Terrestrial
	Odontosoria chinensis (L.) J. Sm.	Terrestrial
	Odontosoria retusa (Cav.) J. Sm.	Terrestrial
Lycopodiaceae	*Lycopodiella cernua* (L.) Pic. Serm.	Terrestrial
Lygodiaceae	*Lygodium circinnatum* (Burm. Fil.) Sw.	Terrestrial
	Lygodium japonicum (Thunb.) Sw.	Terrestrial
	Lygodium microphyllum (Cav.) R. Br.	Terrestrial
Marattiaceae	*Angiopteris evecta* (Forst.) Hoffm.	Terrestrial
Nephrolepidaceae	*Nephrolepis brownii* (Desv.) Hovenk. & Miyam.	Terrestrial
	Nephrolepis cordifolia (L.) C.Presl	Terrestrial
Polypodiaceae	*Microsorum punctatum* (L.) Copel.	Epiphytic
	Microsorum membranifolium (R. Br.) Ching	Epiphytic
	Platycerium coronarium (König) Desv.	Epiphytic
	Selliguea albidosquamata (Blume) Parris	Epiphytic
Psilotaceae	*Psilotum nudum* (L.) P. Beauv.	Epiphytic
Pteridaceae	*Antrophyum reticulatum* (Forst.) Kaulf.	Epiphytic
	Pteris armata C.Presl	Terrestrial
	Pteris ensiformis Burm.	Terrestrial
	Pityrogramma calomelanos (L.) Link	Terrestrial
	Haplopteris ensiformis (Sw.) E.H.Crane	Epiphytic
Schizaeaceae	*Schizaea digitata* (L.) Sw.	Terrestrial
Selaginellaceae	*Selaginella cupressina* (Willd.) Spring	Terrestrial
	Selaginella moellendorfii Hieron.	Terrestrial
	Selaginella remotifolia Spring	Terrestrial
Tectariaceae	*Pleocnemia irregularis* (C.Presl) Holttum	Terrestrial
	Tectaria aurita (Sw.) S. Chandra	Terrestrial
	Tectaria crenata Cav.	Terrestrial
	Tectaria psomiocarpa S.Y. Dong	Terrestrial
Thelypteridaceae	*Chingia ferox* (Blume) Holttum	Terrestrial
	Pneumatopteris glabra (Copel.) Holttum	Terrestrial
	Sphaerostephanos productus (Kaulf.) Holttum	Terrestrial

Figure 2. Map of Northern Luzon (Google Earth 2017) showing the sites of pteridophyte surveys: Adams (Magtoto & Austria, this study), Mt. Baliit (Barcelona 2003) and Mt. Burnay (Iwatzuki & Price 1977)

along the edges of a man-made fishpond.

Among the 47 species of pteridophytes, six species are listed as threatened Philippine plants (DENR Administrative Order No. 2017-11). *Platycerium coronarium* is listed as critically endangered (CR). According to the local residents, this fern was collected from the high mountains of Adams for its aesthetic value and commonly cultivated in the neighborhood. *Ceratopteris thalictroides* and *Psomiocarpa apiifolia* (a Philippine endemic) are categorized as endangered species (EN). *Blechnum egregium* and *Psilotum nudum* are listed as vulnerable (VU) while *Angiopteris palmiformis*, a synonym for *A. evecta,* is listed as other threatened species (OTS).

Psomiocarpa was previously known as a monotypic genus that is endemic to the Philippines (Ding et al 2013, Ding et al. 2014). However, Ding et al. (2013) suggested the reduction of this genus into *Tectaria* and subsequently proposed the name *Tectaria psomiocarpa* for its representative species. Consequently, the current circumscription of *Tectaria* (PPG I 2016) includes the genus *Psomiocarpa*. Henceforth, *Tectaria psomiocarpa* will be used in the succeeding text.

Angiopteris evecta was common in Adams. It was observed on slopes and in the inner parts of the forests. Several species of *Angiopteris*, such as *A. palmiformis*, *A. elmeriana*, *A. uncinata*, *A caudata*, *A. cartilagidens*, *A. pruinosa*, *A. angustifolia* and *A. evecta* have been reported to be found in the Philippines (Pelser et al. 2011), but only *A. evecta* is taxonomically accepted. To date, the taxonomy of *A. evecta*, especially those in Indonesia and Southeast Asia, is poorly known, and thus remains as a species complex (Global Invasive Species Database 2010; June, 2013).

Asplenium oxyphyllum is not included in the current list of Philippine pteridophytes (Pelser et al., 2011); *A. polyodon*, however, is included. *A. polyodon* has been treated as a synonym of *A. falcatum* (Pelser et al. 2011; Salgado and

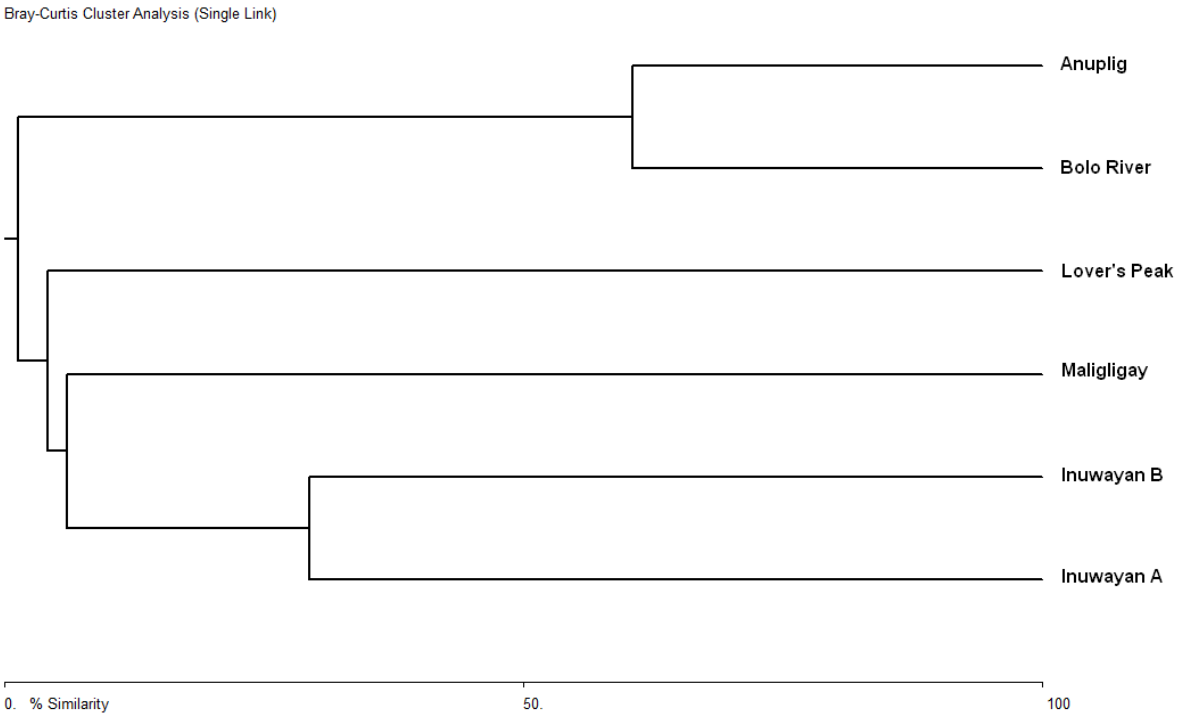

Figure 3. Bray-Curtis Cluster Analysis showing species similarities among the studied sites

Fraser-Jenkins, 2013; Salgado, 2017). It was noted, however, that *A. polyodon* is a distinct species from *A. falcatum* (Salgado and Fraser-Jenkins 2013). Moreover, *A. falcatum* is not found in Malesia (Salgado,2013) and therefore the Philippine species known as such should be named *A. oxyphyllum* (Salgado,2017). It is noteworthy that *A. oxyphyllum* was among the Luzon collections of Cuming (Smith,1841).

Pteridophytes in the locality were used as vegetables and decorations (e.g., fronds are added to flower arrangements and stage decorations), while some were used for medicinal purposes. Some notable species with economic, cultural and medicinal values as perceived by the locals are listed in Table 4. Most of the surveyed pteridophytes have unknown ecosystem services to the locals and were simply considered as weeds.

Fern diversity has been attributed to edaphic variation (Young and León,1989), i.e., the presence of different soil types would result in increased species richness of the pteridophytes. In this study, most of the pteridophytes in Adams were found in areas with Louisiana clay loam. The visual characteristics of the soil matched the descriptions of Louisiana clay loam, i.e., brown to light reddish brown soil surface, sticky when wet, and loose and friable when dry

Table 3. Pteridophytes from Adams compared to other areas in northern Luzon, Philippines.

Pteridophytes from Adams	Mt. Burnay (Iwatsuki & Price 1977)	Mt. Baliit (Barcelona 2003)
Angiopteris evecta (syn. *A. palmiformis*)		+
Aracniodes amabilis	+	
Asplenium nidus	+	
Asplenium oxyphyllum (syn. *A. polyodon*)	+	
Blechnum orientale	+	+
Bolbitis heteroclita	+	
Chingia ferox	+	+
Davallia repens (syn. *Humata obtusa*, *H. vestita*)	+	+
Dicranopteris linearis	+	+
Diplazium esculentum		+
Haplopteris ensiformis (syn. *Vittaria ensiformis*)	+	
Hymenophyllum emerginatum	+	
Lycopodiella cernua (syn. *Lycopodium cernuum*)	+	+
Lygodium circinnatum	+	
Lygodium japonicum	+	
Microlepia speluncae	+	
Microsorum punctatum (syn. *Microsorium punctatum*)	+	
Nephrolepis brownii (syn. *N. multiflora*)	+	
Nephrolepis cordifolia		+
Odontosoria retusa (syn. *Sphenomeris retusa*)	+	+
Pityrogramma calomelanos	+	+
Pneumatopteris glabra		+
Selaginella cupressina		+
Selaginella remotifolia	+	
Selliguea albidosquamata (syn. *Crypsinus albidosquamata*)	+	
Sphaerostephanos productus (syn. *S. smithianus*, *Cyclosorus productus*)	+	

Table 4. Some surveyed pteridophytes and their ecosystem services.

Species	Ecosystem Services
A. nidus	Landscaping
D. esculentum	Vegetable
	Root is prepared into poultice and used to relieve joint pains
B. orientale	Vegetable
	Decoration
D. linearis	Decoration
	Planted to prevent soil erosion
	Used as compost
N. brownii	Landscape gardening
	Decoration
	For floral arrangement
L. cernua	Decoration
	For floral arrangement
L. circinnatum	Rope
	For basket weaving
L. japonicum	Rope
	For basket weaving
L. microphyllum	Rope
	For basket weaving
P. coronarium	Ornamental
A. evecta	Landscaping

(Carating et al., 2014). Young and León (1989) also stated that topographic position (i.e., a hilltop, upper or lower slope, exposed ridge) results in a habitat mosaic, consequently enhancing the diversity of pteridophytes. This was observed in this study and supported by the species similarity and distribution analyzed using Bray-Curtis Cluster Analysis (Figure 3).

As shown in Figure 3, Lover's Peak had a distinct species composition, and this can be attributed to being an open, clear hilltop with signs of slash-and-burn activity. It was dominated by *Dicranopteris linearis*, a known pioneer species growing in newly disturbed areas. There were only few angiosperms (i.e., *Melastoma* sp. and *Psidium guajava*) that grew along with the thick *D. linearis.* This can be explained on the one hand by the findings of Cohen et al. (1995) and Shono et al. (2007) that *D. linearis* forms an ecosystem that inhibits natural regeneration of rainforests due to formation of dense thickets. On the other hand, Mansourian et al. (2005) suggest that what appears as the extensive rhizome formation and abundant litter attributed to *D. linearis* is necessary for degraded lands to undergo stabilization, eventually allowing native plant species to grow through ecological succession.

Pteridophyte species composition in Anuplig and along Bolo River showed resemblance (Fig. 3) as both areas are near bodies of water, i.e., waterfall and river, respectively. In addition, samples from these sites were mostly taken along trailsides, which can be considered as chronically disturbed. The trailsides were dominated by *Nephrolepis brownii*, a pioneer species known to appear immediately after a canopy is opened (Sharpe 2014). Maligligay, Inuwayan B, and Inuwayan A were clustered in Figure 3; tall trees dominate these areas. Inuwayan A, however, had a more closed canopy compared to Maligligay and Inuwayan B, and thus had its own distinct species composition. Shade or low light conditions as determined by the canopy cover was favorable to some fern species, which made Inuwayan A exhibit the greatest number of species including some moisture indicators such as *Hymenophyllum emerginatum* and *Nephrolepis cordifolia.*

Ferns can facilitate the restoration of anthropogenically destroyed lands and forests. Pteridophytes are good pioneer species, that is, they grow on disturbed or disrupted areas, condition the soil, and soon allow other plant species to grow. In addition, Gould et al. (2013) showed that seedlings planted next to ferns showed higher survival compared to seedlings planted without ferns next to them. This is because ferns served as shade providers that inhibit the growth of weedy grasses and as a water collection screen that

enhances moisture near the seedling. Also, allowing fern lands to establish after major disturbance prior to restoration efforts showed better restoration results compared to direct tree planting on disturbed areas (Mansourian et al. 2005).

CONCLUSION

The field-survey conducted in Adams, Ilocos Norte, Philippines recorded 47 species, 34 genera and 21 families of pteridophytes. The record includes six threatened species, namely, *Platycerium coronarium* (CR), *Ceratopteris thalictroides* (EN), *Tectaria psomiocarpa* (EN; endemic to the Philippines), *Blechnum egregium* (VU), *Psilotum nudum* (VU) and *Angiopteris evecta* (OTS). It was observed, however, that there has been an increasing trend in human population, economic activities, introduction of cash crops, and eco-tourism programs in the locality. Consequently, Adams now shows signs of ecological degradation. Researches on ferns as pioneer species and their facilitation of plant communities, as well as on threatened and endemic species are significant for general conservation and restoration projects in the area.

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