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REVIEW ARTICLE **OPEN ACCESS**

Inventory of Ferns and Lycophytes in the Center for Ecological Development and Recreation (CEDAR) at Impalutao, Impasug-ong, Bukidnon Province

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ABSTRACT

An updated species list and conservation assessment of ferns and lycophytes in the Center for Ecological Development and Recreation (CEDAR) at Impalutao, Impasug-ong, Bukidnon Province were provided on the basis of recent field survey and examination of herbarium specimens. Eighty seven species belonging to 20 families and 44 genera were recorded. Of the total 87 species recorded, 67.82 % have >5 number of individuals and with a conservation assessment of few. On the other hand, 5.75 % have 55 to 10 number of individuals and a conservation assessment of common. The remaining 26.43 % have < 10 number of individuals and therefore are considered abundant. When the previous fern checklist of Ms. Mailee S. Duhac in 1998 was compared to this recent inventory it was found that Asplenium decorum, Stenochlaena palustris, Cephalomanes sp., Tapaenidium luzonicum, Nephrolepis biserrata, Lycopodiella cernua, Lycopodium sp., Lecanopteris deparioides, L. sinuosa, Silaginella engleri, S. cupressina, Cyclosorus sp., and Spaherostephanos sp. are the species recorded in the recent field sampling that were not recorded during the sampling of Ms. Duhac in 1998. On the other hand, Pyrossia species marked 1 and 2 were not found during the recent field sampling.
Key words: diversity, pteridophytes, Southern Philippines, threatened species

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INTRODUCTION

Ferns and their allies, collectively called as 'Pteridophytes' are group of non-flowering vascular plants dating back to 360 million years and thus proves to be one of the earliest land encroachers [3]. Ferns are the one of the oldest land plant groups in our earth's surface. Compared with other groups of plants, ferns are usually neglected by the researchers. But the ferns are becoming important for their beauty and economic uses [5]. Traditionally, pteridophytes include the so-called ferns and fern allies because of their shared life cycle as spore-producing plants. Recently, molecular data show that pteridophytes are paraphyletic. They are now recognized as the lycophytes and ferns, the latter of which includes horsetails, whisk ferns, and all eusporangiate and leptosporangiate ferns [1, 2]. They do not produce seeds but reproduce through spores [21]. They are widely distributed both in the tropic and temperate regions especially at higher elevations [20].

The diversity of Philippines vascular plants includes an estimated 1,100 species of ferns and lycophytes distributed among 154 genera and 34 families, according to recent classifications [23]. This estimate continues to increase because of new species discoveries and new records in the Philippines [1, 4].

The number of fern species is about 9,000 but estimates have ranged to as high as 15,000, the number varying because certain groups are as yet poorly studied and because new species are still being found in unexplored tropical areas [11]. In the Philippines, Zamora and Co [26] reported that the country is the habitat of about 930 species of ferns which more than 50 are reported to have actual or potential economic value while twenty-six genera of flowering plants and ferns together with the 296 species are so far known to be endemic. Locally in Bukidnon Province, Amoroso [1] made a checklist of *Pteridophytes* in Mt. Kitanglad. His checklist comprised of 88 species of ferns with descriptions, habitats, and uses [10].

The Center for Ecological Development and Recreation (CEDAR), known as the "Eco-tourism Site in the Heart of Bukidnon" is a non-protected area and a reserved forest that has been managed by the

government since 1912. It has a diverse flora and fauna. CEDAR is located in Barangay Impalutao, Impasug-ong, Bukidnon. It has a total land area of about 1,703 hectares in which 373 hectares is covered by man-made and natural forest. The large area is contained by Mount Kibuwa. CEDAR has five waterfalls and the most notable is Dila Falls. It has an elevation of 600 to 1200 meters above sea level with Mount Kibuwa as the highest. One can see the panoramic view of the mountains of Bukidnon and the towering Mount Kitanglad at Mount Kibuwa. A 100-hectare rattan plantation exists in the area. Hundreds of thousands of white lawaan trees and giant bamboos also contained the forest. The coordinates of the area are 7.8767° N, 125.0683° E [8].

Nonetheless, there is no published checklist of ferns and lycophytes for the reserved forest. Here, such checklist is provided, along with a species conservation assessment of ferns and lycophytes in the area.

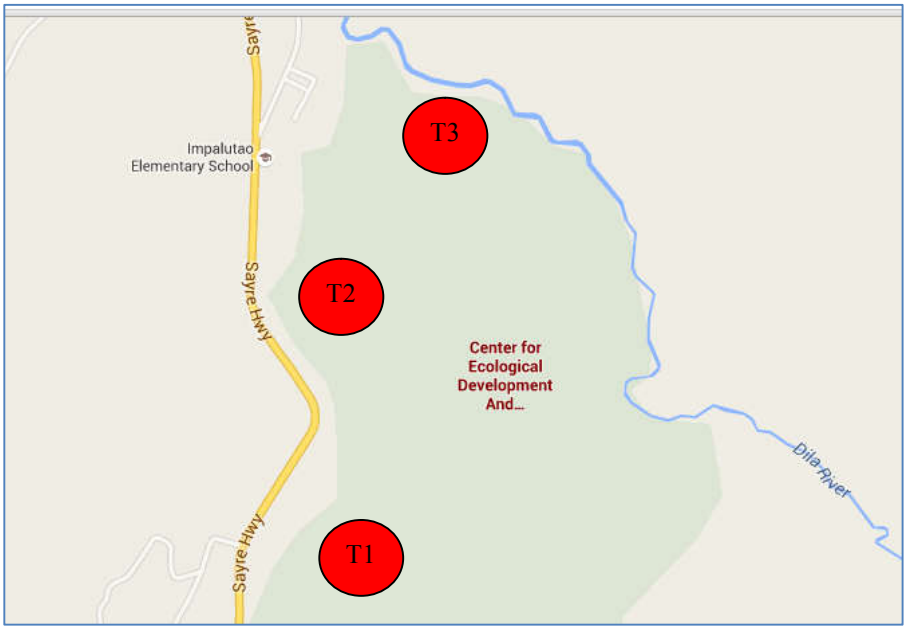

Figure 1.Transect Map of CEDAR, Impalutao, Impasug-ong, Bukidnon Province

MATERIALS AND METHODS

Species Inventory

An inventory of ferns and lycophytes was conducted through series of transect walks from the entrance of CEDAR towards the pool and up to Dila Falls. The transect walk continued going down from Dila Falls down to the opposite side of Cedar's entrance going to their Training Hall.

Collection, Processing, and Identification of Specimens

A minimum of four fertile fronds of each species was collected with a shear and trimming cutter. Small ferns were collected by uprooting the whole plant, removing the soil, and pressing the plant intact. All specimens were processed using the wet method (Hodge 1947). Herbarium specimens were deposited at the Central Mindanao University Herbarium (CMUH). Species identifications are based on the specimens deposited at CMUH and were performed by consulting the following monographs, floras, and other publications: Copeland [7]; Holttum [12-18]; Kramer [19]; Zamora and Co [26] and digitized plant specimens available in Global Plants on JSTOR. The classification systems used are those of Smith *et al*. [22] and Rothfels *et al*. [21].

RESULTS AND DISCUSSION

Eighty seven species, belonging to 20 families and 44 genera, were recorded. Of these, 81 species are ferns and 6 are lycophytes (Tables 1 & 2). The families with the highest number of species are Polypodiaceae (23 species), Aspleniaceae (10), Dryopteridaceae (9), and Thelypteridaceae (7) and Vittariaceae (5).

Table 1. Total number of genera and species of ferns and lycophytes documented from CEDAR

	Family	Number of Genera	Number of Species
1	Aspleniaceae	1	10
2	Blechnaceae	2	2
3	Cyatheaceae	1	1
4	Davalliaceae	1	3
5	Dennstaedtiaceae	1	2
6	Dryopteridaceae	5	9
7	Gleicheniaceae	2	2
8	Hymenophylllaceae	2	2
9	Lindsaeaceae	2	2
10	Lomariopsidaceae	1	3
11	Lycopodiaceae	2	2
12	Lygodiaceae	1	3
13	Marattiaceae	1	1
14	Polypodiaceae	10	23
15	Pteridaceae	1	3
16	Selaginellaceae	1	4
17	Tectariaceae	1	1
18	Thelypteridaceae	5	7
19	Vittariaceae	2	5
20	Woodsiaceae	2	2
	TOTAL	**44**	**87**

Several factors may affect local montane species richness in the Philippines such as the size of the area sampled, climatic conditions, soil type, and geographic location [2]. Species richness is also affected by human activities such as the conversion of forests to agricultural or industrial lands and pollution. With increasing utilization of land and natural resources, it is feared that many of these threatened taxa will become yet rarer, more vulnerable and endangered, and in several cases may finally become extinct, as any disturbance or imbalance in their narrowly confined ecosystems is liable to lead to their extermination [4].

Table 2. Checklist and Assessment of ferns and lycophytes in the Center for Ecological Development and Recreation (CEDAR)

Aspleniaceae	*Asplenium apoense* Copel.	>5	Few
	A. baileyanum (Domin.) Watts	>5	Few
	A. decorum Kunze	>5	Few
	A. excisum Presl.	>5	Few
	A. longgissimum Blume	>5	Few
	A. nidus Linn.	5 to 10	Common
	A. phyllitidis Don.	>5	Few
	A. *spathulinum* J. Smith	>5	Few
	A. tenerum Forster	>5	Few
	Asplenium sp. 1	>5	Few
Blechnaceae	*Blechnum orientale* L.	>5	Few
	Stenochlaena palustris (Burm.f.) Bedd.	>5	Few
Cyatheaceae	*Alsophila fuliginosa* Christ	>5	Few
Davalliaceae	*Davallia denticulata* (Burm.) Mettenius	5 to 10	Common

	D. solida (Forst.) Sw	5 to 10	Common
	D. trichomanoides Blume	< 10	Abundant
Dennstaedtiaceae	*Microlepia biformes*	>5	Few
	Microlepia speluncae (Linn.) Moore	>5	Few
Dryopteridaceae	*Arachnoides aristata* Forster	>5	Few
	Bolbitis heroclita (C.Presl) Ching	>5	Few
	Bolbitis sp.	>5	Few
	Dryopteris sparsa (Bon) O. Kuntze	>5	Few
	Elaphloglossum angulatum (Blume) Moore	>5	Few
	E. callifolium (Blume) Moore	>5	Few
	E. petiolatum (Swartz) Urban	>5	Few
	Pleocnemia irregularis (C.Presl) Holttum	< 10	Abundant
	P. macrodonta (Fée) Holttum	< 10	Abundant
Gleicheniaceae	*Dicranopteris linearis (Burm) Underwood*	< 10	Abundant
	Gleichenia laevigata (Wild.) Presl	< 10	Abundant
Hymenophyllaceae	*Cephalomanes sp.*	>5	Few
	Hymenophyllum sp.	>5	Few
Lindsaeaceae	*Lindsaea cultrata Willd* (Phylogr.)	>5	Few
	Tapeinidium luzonicum (Hook.) K.U.Kramer	< 10	Abundant
Lomariopsidaceae	*Nephrolepis bisserata (Sw.) Schott*	< 10	Abundant
	N. cordifolia (L.) C.Presl	< 10	Abundant
	N. hirsutula	< 10	Abundant
Lygodiaceae	*Lygodium circinnatum* (Burm.f.) Sw.	>5	Few
	L. flexuosum (L.) Sw.	>5	Few
	L. japonicum (Thunb.) Sw	>5	Few
Lycopodiaceae	*Lycopodiella cernua*	>5	Few
	Lycopodium sp.	>5	Few
Marattiaceae	*Angiopteris evecta* (G.Forst.) Hoffm.	>5	Few
Polypodiaceae	*Belvisia revoluta* (Blume) Copel.	>5	Few
	B. squamata (Hieron. Christ) Copel.	>5	Few
	Belvisia sp. 1	>5	Few
	Belvisia sp. 2	>5	Few
	Belvisia sp. 3	>5	Few
	Colysis bolsterii Copel	>5	Few
	Crypsinus glaucus (J. Sm) Copel	>5	Few
	Crypsinus sp.	>5	Few
	Cyclosorus ensifer	>5	Few
	Drynaria quercifolia (L.) J.Sm.	< 10	Abundant
	Drynaria sp.	< 10	Abundant
	*Drynariopsis heracleai (Runze)*Ching	>5	Few
	Goniophlebium subauriculatum (Blume) Presl.	>5	Few
	Goniophlebium sp.	>5	Few
	Lecanopteris deparioides (Ces.) Baker	>5	Few
	L. sinuosa (Wall. ex Hook.) Copel.	>5	Few

	Microsorum alternifolium Wild.	< 10	Abundant
	M. palmatum Fee	< 10	Abundant
	Mircosorum sp.	< 10	Abundant
	Photinopteris speciosa (Blume) Presl.	>5	Few
	Pyrossia adnacens	>5	Few
	P. sphaerosticha (Mett.) Ching	>5	Few
	P. pelosilloides (Linn.) Price	>5	Few
	*Pyrossia sp.*1	>5	Few
	*Pyrossia sp.*2	>5	Few
Pteridaceae	*Pteris glaucovirens* Goldman	5 to 10	Common
	P. longipinnula Wallich	5 to 10	Common
	P. mutilate	< 10	Abundant
Selaginellaceae	*Selaginella longipina*	< 10	Abundant
	S. *usterii*	< 10	Abundant
	S. engleri Hieron	< 10	Abundant
	S. cupressina (Willd.) Spring	< 10	Abundant
Tectariaceae	*Tectaria meyanthidis*	>5	Few
Thelypteridaceae	*Christella parasitica (Linn.) Lev*	< 10	Abundant
	Pneumatopteris costata (Back) Holtt.	>5	Few
	Phronephrium aspersum Sheiland Tsai	< 10	Abundant
	Phronephrium sp.	< 10	Abundant
Vittariaceae	*Anthrophyum semiscostatum* Blume	>5	Few
	Vittaria ensiformes Swartz.	< 10	Abundant
	V. hecistophylla Copel	< 10	Abundant
	V. stenophylla Copel CS.	< 10	Abundant
	V. zosterifolia Willd.	< 10	Abundant
Woodsiaceae	*Diplazium esculentum* (Retz.) Sw.	< 10	Abundant
	Diplaziopsis javanica (Blume) Christ.	>5	Few

Among the 87 identified species in the area, 67.82 % have >5 number of individuals and with a conservation assessment of few. On the other hand, 5.75 % have 55 to 10 number of individuals and a conservation assessment of common. The remaining 26.43 % have < 10 number of individuals and therefore are considered abundant. The result can be attributed to the fact that CEDAR as recreational park has already been so disturbed.

Table 3. Comparison of 2017 and 1998 (Ms. Duhac's) Fern Checklists

	Species Name	**1998**	**2017**
Aspleniaceae	*Asplenium apoense* Copel.	**Present**	**Present**
	A. baileyanum (Domin.) Watts	**Present**	**Present**
	A. decorum Kunze	**Absent**	**Present**
	A. excisum Presl.	**Present**	**Present**
	A. tenerum Forster	**Present**	**Present**
	A. nidus Linn.	**Present**	**Present**
	A. phyllitidis Don.	**Present**	**Present**
	A. spathulinum J. Smith	**Present**	**Present**
	A. tenerum Forster	**Present**	**Present**
	Asplenium sp. 1	**Present**	**Present**
Blechnaceae	*Blechnum orientale* L.	**Present**	**Present**
	Stenochlaena palustris (Burm.f.) Bedd.	**Absent**	**Present**
Cyatheaceae	*Alsophila fuliginosa* Christ	**Present**	**Present**
Davalliaceae	*Davallia denticulata* (Burm.) Mettenius	**Present**	**Present**
	D. solida (Forst.) Sw	**Present**	**Present**

	D. trichomanoides Blume	**Present**	**Present**
Dennstaedtiaceae	*Microlepia biformes*	**Present**	**Present**
	Microlepia speluncae (Linn.) Moore	**Present**	**Present**
Dryopteridaceae	*Arachnoides aristata* Forster	**Present**	**Present**
	Bolbitis heroclita (C.Presl) Ching	**Present**	**Present**
	Bolbitis sp.	**Present**	**Present**
	Dryopteris sparsa (Bon) O. Kuntze	**Present**	**Present**
	Elaphloglossum angulatum (Blume) Moore	**Present**	**Present**
	E. callifolium (Blume) Moore	**Present**	**Present**
	E. petiolatum (Swartz) Urban	**Present**	**Present**
	Polystichum fuscum Copeland	**Present**	**Absent**
	Pleocnemia irregularis (C.Presl) Holttum	**Present**	**Present**
	P. macrodonta (Fée) Holttum	**Present**	**Present**
Gleicheniaceae	*Dicranopteris linearis (Burm) Underwood*	**Present**	**Present**
	Gleichenia laevigata (Wild.) Presl	**Present**	**Present**
Hymenophyllaceae	*Cephalomanes sp.*	**Absent**	**Present**
	Hymenophyllum sp.	**Present**	**Present**
Lindsaeaceae	*Lindsaea cultrata Willd* (Phylogr.)	**Present**	**Present**
	Tapeinidium luzonicum (Hook.) K.U.Kramer	**Absent**	**Present**
Lomariopsidaceae	*Nephrolepis biserrata* (Sw.) Schott	**Absent**	**Present**
	N. cordifolia (L.) C.Presl	**Present**	**Present**
	N. hirsutula	**Present**	**Present**
Lygodiaceae	*Lygodium circinnatum* (Burm.f.) Sw.	**Present**	**Present**
	L. flexuosum (L.) Sw.	**Present**	**Present**
	L. japonicum (Thunb.) Sw	**Present**	**Present**
Lycopodiaceae	*Lycopodiella cernua*	**Absent**	**Present**
	Lycopodium sp.	**Absent**	**Present**
Marattiaceae	*Angiopteris evecta* (G.Forst.) Hoffm.	**Present**	**Present**
Polypodiaceae	*Belvisia revoluta* (Blume) Copel.	**Present**	**Present**
	B. squamata (Hieron. Christ) Copel.	**Present**	**Present**
	Belvisia sp. 1	**Present**	**Present**
	Belvisia sp. 2	**Present**	**Present**
	Belvisia sp. 3	**Present**	**Present**
	Colysis bolsterii Copel	**Present**	**Present**
	Crypsinus glaucus (J. Sm) Copel	**Present**	**Present**
	Crypsinus sp.	**Present**	**Present**
	Drynaria quercifolia (L.) J.Sm.	**Present**	**Present**
	Drynaria sp.	**Present**	**Present**
	*Drynariopsis heracleai (Runze)*Ching	**Present**	**Present**
	Goniophlebium subauriculatum (Blume) Presl.	**Present**	**Present**
	Goniophlebium sp.	**Present**	**Present**
	Lecanopteris deparioides (Ces.) Baker	**Absent**	**Present**
	L. sinuosa (Wall. ex Hook.) Copel.	**Absent**	**Present**
	Microsorum alternifolium Wild.	**Present**	**Present**
	M. palmatum Fee	**Present**	**Present**
	Mircosorum sp.	**Present**	**Present**
	Photinopteris speciosa (Blume) Presl.	**Present**	**Present**
	Pyrossia adnacens	**Present**	**Present**
	P. sphaerosticha (Mett.) Ching	**Present**	**Present**
	P. pelosilloides (Linn.) Price	**Present**	**Present**

	*Pyrossia sp.*1	**Present**	**Absent**
	*Pyrossia sp.*2	**Present**	**Absent**
Pteridaceae	*Pteris glaucovirens* Goldman	**Present**	**Present**
	P. longipinnula Wallich	**Present**	**Present**
	P. mutilate	**Present**	**Present**
Selaginellaceae	*Selaginella longipina*	**Present**	**Present**
	S*. usterii*	**Present**	**Present**
	S. engleri Hieron	**Absent**	**Present**
	S. cupressina (Willd.) Spring	**Absent**	**Present**
Tectariaceae	*Tectaria meyanthidis*	**Present**	**Present**
Thelypteridaceae	*Christella parasitica (Linn.) Lev*	**Present**	**Present**
	Cyclosorus ensifer	**Present**	**Absent**
	Cyclosorus sp.	**Absent**	**Present**
	Pneumatopteris costata (Back) Holtt.	**Present**	**Present**
	Phronephrium aspersum Sheiland Tsai	**Present**	**Present**
	Phronephrium sp.	**Present**	**Present**
	Sphaerostephanos unitus (L.) Holttum	**Present**	**Present**
	Sphaerostephanos sp.	**Absent**	**Present**
Vittariaceae	*Anthrophyum semiscostatum* Blume	**Present**	**Present**
	Vittaria ensiformes Swartz.	**Present**	**Present**
	V. hecistophylla Copel	**Present**	**Present**
	V. stenophylla Copel CS.	**Present**	**Present**
	V. zosterifolia Willd.	**Present**	**Present**
Woodsiaceae	*Diplaziopsis javanica* (Blume) Christ.	**Present**	**Present**
	Diplazium esculentum (Retz.) Sw.	**Present**	**Present**

Results revealed that *Asplenium decorum, Stenochlaena palustris, Cephalomanes sp., Tapaenidium luzonicum, Nephrolepis biserrata, Lycopodiella cernua, Lycopodium sp., Lecanopteris deparioides, L. sinuosa, Silaginella engleri, S. cupressina, Cyclosorus sp., and Spaherostephanos sp.* are the species recorded in the recent field sampling that were not recorded during the sampling of Ms. Duhac in 1998. On the other hand, Pyrossia species marked 1 and 2 were not found during the recent field sampling. The disturbance brought about by people wha re just come and go in the place brought the presence of other fern and lycophytes species while the lost of other species can also be attributed to anthropogenic pressures.

In many regions it is now difficult to find any extensive area of natural forest and the effective strict protection of small token-areas selected for their species-diversity is now of increasingly important [6].

According to the study of Duhac [9], there are 20 families, 39 genera and 79 species of Pteridophytes in CEDAR during that time. In which 77 species are fern and 2 are lycophytes. But since we are using different sampling technique we have different results. It is evident because CEDAR is typically having adequate temperature, since, in order to survive, the ferns requirements include moisture in the soil, moisture in the air, sufficient light for photosynthesis, protection from freezing and dependability and continuity of the previous requirements [2], it was found that the lower montane area of CEDAR having an elevation of 700 meters above sea level was able to meet such requirement for ferns to grow.

CONCLUSION

There were 87 species of ferns and lycophytes found in CEDAR, Impalutao, Impasug-ong, Bukidnon Province. There are several factors that ferns need to survive; this primarily includes the physico-chemical parameters like soil organic matter content, pH, and the extrinsic factors including the location, elevation, temperature and air pressure [1]. This only means that the area in CEDAR is able to supply the requirements of the ferns to thrive naturally.

RECOMMENDATIONS

In the mentioned findings and conclusions above, the researchers recommend the following:

1. It is highly recommended that a thorough exploration must be made in order to conduct a re-inventory on the species of both ferns and lycophytes in the area so that the real profile of the recreational park of the forest will be established.
2. Based on the findings, it is further recommended that the area should be maintained protected to avoid loss and acquire abundance of fern species.
3. Species-specific conservation management strategy should be applied to avoid the risk of extinction of fern species.

4. Formulate Barangay ordinance that will regulate human activities, create public awareness and to ask officials to conserve properly the area.
5. A monitoring program in charge of determining changes of fern species density CEDAR must be created to determine the population dynamics if these species and the exploitation of economically important species would be regulated.
6. As a future conservation biologist, one must promote conservation strategies especially on ferns.

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